INTERNATIONAL GEOLOGICAL CONGRESS

REPORT OF THE EIGHTEENTH SESSION
GREAT BRITAIN 1948

PART XV (15)

PROCEEDINGS OF THE

INTERNATIONAL PALEONTOLOGICAL UNION

LONDON
1950

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General Editor: A. J. Butler

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Edited by
C. J. STUBBLEFIELD

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FOREWORD

THE International Paleontological Union was founded on July 27th, 1933, at a meeting of representative palaeontologists held during the Sixteenth Session of the International Geological Congress (Washington) to serve (*inter alia*) as a unifying body of palaeontologists attending that and future congresses. The first assembly of the Union took place as part of the Seventeenth Session of the Congress (Moscow) in 1937 when a constitution and by-laws were agreed. These were printed in the *Report of the Seventeenth Session of the International Geological Congress 1937*, Vol. 1, 1939, pp. 140–141, and, in modified form, in the *Journal of Paleontology*, Vol. 12, 1938, pp. 303-304. The Union is an informal body and between congresses, chiefly through its Secretary, acts as a liaison between palaeontologists.

In preparation for the Union's meetings at the Eighteenth International Geological Congress the Officers appointed a small London sub-committee in 1938 and arrangements were made for the 1940 meeting, subsequently abandoned. In 1947, this sub-committee was enlarged and comprised A. Morley Davies (Vice-President of the Union) as Chairman, O. M. B. Bulman, W. N. Edwards, H. L. Hawkins, C. D. Ovey, D. M. S. Watson, W. F. Whittard, and C. J. Stubblefield, the last acting as Secretary. This committee received advice from the Secretary of the Union and selected subjects for discussion such as were thought likely to be of general interest to an international gathering of palaeontologists. With the approval of the President and Secretary of the Union, three topics were chosen, papers were invited and three meetings were arranged; the report of these follows.

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Contents

PROCEEDINGS OF THE INTERNATIONAL PALEONTOLOGICAL UNION, LONDON MEETING 1948

THE International Paleontological Union held three open meetings for the reading of papers; and the Council of the Union met three times, with thirty-four members attending.

At the first open meeting, held on August 27th, with President P. E. PRUVOST in the chair, the following papers relating to special aspects of palaeontological publications and bibliography were read.

Palaeontological publication and bibliography in Britain, by H. L. HAWKINS.

Progress of the Catalogue of North American Devonian Fossils, by A. S. WARTHIN, JR. (read by B. F. HOWELL).

A clearing house for microfossil literature and specimens, by BROOKS F. ELLIS (read by M. P. WHITE).

Introduction to " Planches Inédites " of Alcide d'Orbigny, by M. LYS.

A proposal that there be a Bureau of the International Paleontological Union, by S. H. HAUGHTON.

La documentation paléontologique: le Centre d'Études et de la Documentation paléontologiques français, by J. ROGER.

The reading of these papers was followed by a general discussion of current problems of palaeontological publication and the need for bibliographical centres. Professor A. DESIO announced the formation of La Società Paleontologica Italiana and the adoption by that Society of La Rivista Italiana di Paleontologia e Stratigrafia as its official journal.

At the second open meeting of the Union, held on August 30th, with Vice-President A. MORLEY DAVIES presiding, nine papers dealing with foraminifera and their use in stratigraphical palaeontology were presented.

The uses of foraminifera in Lower Jurassic stratigraphy, by T. BARNARD.

Répartition stratigraphique de quelques grands foraminifères dans le Flysche crétacé supérieur Nord Pyrénéen (S.W. France), by Mme. Y. GUBLER.

Sur l'évolution de la faune de foraminifères des couches de passage du Crétacé au Tertiaire, by P. MARIE (read by J. Roger).

(A paper entitled " Foraminiferen als Leitfossilien in der Oberkreide insbesondere Nordwest-Deutschlands," by H. HILTERMANN, was read in title only).

Mikropaläontologie und Stratigraphie in den tertiären Becken und in der Flyschzone von Österreich, by R. GRILL (read by G. GÖTZINGER).

Stratigraphy of the Caenozoic of the East Indies based on foraminifera, by I. M. VAN DER VLERK.

Foraminifera in Australian stratigraphy, by Miss I. CRESPIN (read by H. G. RAGGATT).

The stratigraphical value of foraminifera in New Zealand (based on correspondence and literature from Dr. H. J. FINLAY), by C. D. OVEY.

Foraminifera and the stratigraphy of the Indo-Afghan border, by L. M. DAVIES.

Un foraminifère nouveau du Lutétien supérieur d'Aquitaine, by J. CUVILLIER.

The third open meeting of the Union, at which Vice-President W. J. JONGMANS presided, was held on August 31st and was devoted to a discussion of problems of palaeozoological nomenclature. Mr. FRANCIS HEMMING, Secretary of the International Commission of Zoological Nomenclature, gave an account of the work and plans of the Commission, and a paper proposing a new system of quadrinominal nomenclature of animals, written by L. STRAUSZ, was read, in the absence of the

author, by C. J. STUBBLEFIELD. Mr. HEMMING stated that a new and revised edition of the Rules of Zoological Nomenclature would be published soon, in which many of the present Opinions would be incorporated in the Rules.

The first meeting of the Council of the International Paleontological Union was held on August 26th, with President P. E. PRUVOST presiding and twenty-eight members present.

THE PRESIDENT announced that the Commission on Fossil Man, which had previously been a commission of the International Geological Congress, had been transferred to the International Paleontological Union, in accordance with the resolution of the Council of the Seventeenth International Geological Congress.

C. J. STUBBLEFIELD read a statement concerning the proposed International Union of Geology and discussed the possible relations of this union to the International Paleontological Union. He recommended that the Council of the International Paleontological Union defer positive action in affiliating itself to the International Council of Scientific Unions until Congress Council's decision be made known. It was voted to authorize the President to appoint Dr. Stubblefield as the Union's representative in any negotiations taking place before the convening of the Nineteenth International Geological Congress, and instruct him to keep the President and Secretary informed of developments and advise them of any action that should, in his opinion, be taken.

THE PRESIDENT laid before the Council a request by Professor O. H. Schindewolf that it consider the possibility of its giving support to the attempt that he was making to revive the palaeontological abstracts section of the Neues Jahrbuch für Mineralogie, Geologie und Paläontologie, which during the war was combined with the abstracts section of the Geologisch-Paläontologischen Zentralblatt under the title Zentralblatt für Mineralogie, Geologie und Paläontologie. At the President's request PROFESSOR SCHINDEWOLF informed the Council concerning the effort that was being made to increase the size of the then very small edition of the section and bespoke the Council's assistance in this undertaking. It was voted to instruct the President to confer with the Bureau of the International Geological Congress which was then studying ways and means of reviving some of the abstract journals in the geological field and to do everything possible to insure that, in its consideration of this problem, the Bureau kept the interests of palaeontology in mind.

The second meeting of the Council was held on August 27th, with the President in the chair and nineteen members present.

The possibility that the Union might be able to assist the Centre d'Études et de Documentation Paléontologiques was discussed. It was decided that, since the most effective support for this organisation would probably come from UNESCO, action by the International Paleontological Union on this matter should be deferred until it was known whether an International Union of Geology affiliated to the International Council of Scientific Unions might be formed, in which case the International Paleontological Union might also wish to become so affiliated.

Vice-President JONGMANS reported on the status of the *Fossilium Catalogus*, stating that the publisher of this work, then in the Russian Zone of Occupation of Germany, had informed him that the stock of the parts of the *Fossilium Catalogus* printed before and during the late war was still in his hands, and that it was hoped that the parts printed during the war could soon be distributed. Dr. JONGMANS stated that plans were being considered that would probably lead to the publication of additional parts within the next few years.

The third meeting of the Council was held on August 28th, with the President presiding and eighteen members present.

THE SECRETARY read the report of the Acting Treasurer, Dr. J. B. REESIDE, who was unable to be present because of illness. The report was accepted.

The President presented the slate of new officers that had been prepared by the Nominating Committee. These officers were unanimously elected.

President ...	...	A. MORLEY DAVIES
Vice-Presidents	...	H. J. HARRINGTON B. F. HOWELL W. J. JONGMANS A. KRYSHTOFOVICH J. PIVETEAU B. SAHNI C. J. STUBBLEFIELD Y. C. SUN V. VAN STRAELEN
Secretary ...	...	H. E. VOKES Johns Hopkins University, Baltimore, Maryland, U.S.A.
Treasurer ...	...	LEIF STØRMER University of Oslo, Oslo, Norway.

The Secretary read the report of the Committee on Proterozoic Correlation, of which committee he was the chairman.

The chairmen of other committees who were present reported that, because of the war, which had prevented their committees from functioning, they were unable to present reports, but that they hoped to be able to do so at the next session of the Union. It was voted to continue all of the committees.

The Council instructed the Secretary to express to the Local Committee of the Union and to the officers of the Eighteenth International Geological Congress its thanks for the very excellent arrangements that they had made for the London session of the Union, which had so greatly helped to make the meetings successful.

THE SECRETARY expressed to PROFESSOR PRUVOST the gratitude of the Council for his long and faithful services as President.

The Council adjourned until the next session of the Union, which will be held in Algiers in 1952, at the time of the Nineteenth International Geological Congress.

B. F. HOWELL,
Secretary.

1. SPECIAL ASPECTS OF PALAEONTOLOGICAL PUBLICATION

The first open meeting of the Union was held on August 27th with the President, P. E. PRUVOST (France), in the chair. The meeting was occupied with the reading of six papers relating to the topic stated above, followed by a discussion. The papers are printed in the order in which they were read and the general discussion follows the last paper.

PALAEONTOLOGICAL PUBLICATION IN BRITAIN

By H. L. HAWKINS

Great Britain

WITH one exception, there are no societies or periodicals wholly devoted to the publication of palaeontological matters in Britain. The functions and scope of the Palaeontographical Society will be considered at the end of this communication; for the present the numerous other media of publication may be cited.

Palaeontological writings can be classed as either essentially stratigraphical or essentially morphological and philosophical. Such a classification does not necessarily correspond with one based on bulk, although on the whole stratigraphical papers tend to be relatively brief, and morphological ones are apt to be more voluminous. For our present purpose a three-fold division into papers, monographs and reviews is perhaps the most convenient.

I. SHORT OR MEDIUM PAPERS. OCTAVO

Two periodicals unconnected with any particular societies are available for papers averaging ten pages and one or two plates in size. These are the *Geological Magazine*, founded in 1864, and the *Annals and Magazine of Natural History* which has been published continuously since the early years of last century. Both of these accept short papers on Palaeozoology and Palaeobotany. The *Geological Magazine* normally publishes faunistic and philosophical papers, while the *Annals* often include systematic work; but the distinction is by no means rigid.

Among the journals of London societies that of the Geological Society naturally takes first place. Although the stratigraphical and faunistic aspects of Palaeontology are those most often brought before the society, morphological and philosophical contributions appear not infrequently in the *Quarterly Journal*. For almost a century the society has not issued *Transactions* in quarto, but should this form of publication be resumed, it would afford scope for monographic papers as in the past.

The Zoological and Linnaean Societies not infrequently publish palaeozoological and palaeobotanical papers respectively, particularly those of a morphological trend; and the Malacological Society accepts almost as many contributions on fossil as on recent Mollusca.

The Geologists' Association occasionally includes palaeontological papers in its *Proceedings*; the majority of these are usually incidental to stratigraphy.

In a slightly different category comes the *Bulletin of the Geological Survey* (which has not yet restarted since the war), where systematic and faunistic papers are included. These papers are contributed mainly by officers of the Survey staff, but by no means exclusively so; they are, however, normally restricted to the description and discussion of materials in the collections of the Survey.

Several provincial societies issue Proceedings which may include palaeontological papers. The proportion of such papers tends, however, to depend on the oscillating interests of the societies' more active members; at the present time the Yorkshire and Glasgow Geological Societies seem to be most prolific in palaeontological output; but in the past, and sporadically to-day, many important works have appeared in the proceedings of other societies. Mention may be made of the Cotteswold Field Club, the Dorset Field Club, the Bristol Naturalists' Society, the Manchester Literary and Philosophical Society, the Liverpool Geological Society and the Leeds Geologists' Association. In addition, a magazine known as the *Yorkshire Naturalist* often contains brief palaeontological notes.

II. REVIEWS AND ABSTRACTS

The periodical called *Biological Reviews* occasionally contains articles on palaeontological subjects, chiefly philosophical.

The *Zoological Record*, which gives a tabulated list of new generic and specific names introduced during the year prior to its publication, aims to cover the field of Palaeozoology as fully as that of Neozoology—six or more of its present recorders are active Palaeontologists. In addition to *nomina nova*, the *Record* attempts to indicate established genera about which important new information has appeared, but there is no actual abstracting of papers. The volumes of the *Zoological Record* formed the basis of S. A. Neaves' *Nomenclator Zoologicus*, which appeared in four volumes between 1939 and 1940 and indexed all generic names in Zoology and Palaeozoology introduced between 1758 and 1935.

There is issued monthly a typewritten brochure of abstracts of Mesozoic and Cainozoic palaeontological papers, compiled by the Oil Companies. This is not technically published, for it cannot be purchased; but copies are sent to the British Museum of Natural History, the library of the Geological Survey and the Geological Society. Though limited in scope, it is the only efficient series of palaeontological abstracts compiled in Britain.

I am unaware of any scheme for the compilation or issue of palaeobotanical abstracts.

III. MONOGRAPHS. QUARTO

The British Museum of Natural History publishes illustrated catalogues of its collections, and some of these are inevitably palaeontological. Often such catalogues are virtually Monographs, and some of them are actually so designated. They are, of course, not limited to British fossils.

The Geological Survey issues infrequent palaeontological Memoirs. In the early days of the Survey the *Decades*, in which systematic descriptions of new and familiar British fossils were illustrated by exquisite plates, did not persist for many years; but the new series of memoirs (interrupted by the war) are valuable contributions to British palaeontology.

The *Transactions* of the Royal Societies of London and Edinburgh include a fair proportion of palaeontological monographs, and provide media of publication for writers of extensive treatises, systematic or morphological.

Lastly, the Palaeontographical Society, which celebrated its centenary last year, issues an annual volume in which monographs appear in serial parts. The original object of the Society was declared as the Utopian ideal of publishing figures and descriptions of every species of fossil found in Britain; but the experience of a century has introduced some chastened modifications. Although most of the Monographs are systematic, some are stratigraphically faunistic, and of late years there has been a tendency to an increasing inclusion of morphological and comparative matter. The society is purely

a publishing one, and the influence of changing values since 1914 may be seen in the relative slenderness of many recent volumes. Its published *Monographs* treat of most groups of fossil animals, and a less comprehensive selection of fossil plants; there are still serious gaps to be filled, and earlier volumes are ripe for revision. Plenty of undescribed material remains to fill the second hundred volumes, but financial and technical shortages impede the progress of the work. These have not, however, been allowed to lower the high standard of production set a century ago, when a bulky quarto volume was not incredibly cheap at the price of one guinea.

PROGRESS OF THE CATALOGUE OF NORTH AMERICAN DEVONIAN FOSSILS

By A. S. WARTHIN, Jr.
U.S.A.

(Communicated by Ben F. Howell, U.S.A.)

THIS project aims at eventually issuing for each species of North American Devonian invertebrates a card, 8½in. by 11in. in size, which will carry all the pertinent information about that species. On each card there will be: (*a*) the original reference to the species, (*b*) the current generic reference, (*c*) the original description of the species and, in some cases, a revised description, (*d*) the stratigraphic range and the geographic range of the species, (*e*) the location of the holotype or syntypes, (*f*) additional observations made by the specialist who prepared the cards, and (*g*) the original illustration, sometimes with supplementary illustrations.

The feasibility of a scheme of this kind and scope was discussed for some years among American palaeontologists, and at the 1930 meeting of the Paleontological Society of America the late Dr. E. M. Kindle, of the Geological Survey of Canada, formally proposed that the Society sponsor such a project. The Society concurred, appointed a committee to administer the Catalogue, but made no financial commitments. The Wagner Free Institute of Science, Philadelphia, agreed to act as the publisher.

The committee in charge then secured the services of specialists who agreed to prepare the cards for various zoological units in which the Catalogue was to be published. These palaeontologists agreed to do the work without remuneration.

The first cards to be published, covering the ammonoid cephalopods, were issued in 1936. To date nine units, containing 686 cards, have been published; others are in preparation.

The cards are reproduced by the full-tone collotype process. The original copy for each card can thus contain clippings from printed publications, typed material, reproductions of the original figures, new illustrations of any type, etc., all assembled on a single piece of cardboard. The engraver routs all edges of clippings from the negative, so the result is a clean card.

Publication is irregular, no effort being made to have a set schedule.

Interested persons may subscribe for either single units of the entire series. At present about 125 copies of each unit are shipped within the first few months after its publication. Sales then drop to a small but relatively steady trickle of one to ten copies a year, so that the first units, published in editions of 200, are now almost out of print. The current edition is 225 copies. Since the printer holds the negatives of all cards it will be possible to reprint the earlier units if demand should warrant.

The cost to purchasers of the last unit published was seven cents per card, plus shipping charges. Earlier units were printed more cheaply, and may be purchased for as little as five cents per card. At these prices it is necessary to sell about 160 sets of each unit in order to pay the cost of printing, without taking into account the overhead costs of the Wagner Free Institute of Science.

Some of the advantages of the Catalogue to the user may be mentioned. Prominent among these is, of course, the fact that the Catalogue reproduces original figures and descriptions of many species from old publications, difficult of access and, in addition, in many cases, new and better figures. To a specialist on a single group, a unit of the cards covering that group is his cheapest possible means of attaining a complete coverage of species. The cards also contain much new information on geologic and geographic ranges, location of type specimens, and new generic assignments. In the case of many of the units the author has thoroughly revised the description and illustration of the species. This even includes, in some units, a listing of species discarded as synonyms or unrecognizable forms.

Some suggestions have been made that, for reasons of economy and saving in bulk, the Catalogue should be issued in strips of microfilm. In order to produce a microfilm of appearance equivalent to the present cards, however, it would still be necessary to photograph the pasted-up copy at natural size, and rout out the large negative, before photographic reduction on the film strip. Savings in cost, therefore, may not be as great as a casual consideration of the matter would suggest, furthermore many subscribers still lack adequate microfilm reading devices. Most important of all, perhaps, is the fact that in microfilm strips the loose-leaf character of the present cards would be lost. We feel that this loose-leaf character is especially valuable to the user in that it permits addition of new cards at their proper places, or the transfer of species from one genus to another.

A word as to the nomenclatural status of the Catalogue is perhaps in order. Although recognized in bibliographies as a regular publication of the Wagner Free Institute of Science, the circulation of the Catalogue is admittedly small at present. For that reason it has always been the policy of the administrative committee that no new names of any rank shall be allowed publication in the Catalogue.

It is obvious that a Catalogue of this sort requires a tremendous amount of unpaid labour in its preparation. For that reason the appearance of units will probably always be slow and irregular. Each unit published, however, makes the project as a whole more valuable, and it is the feeling of the administrative committee that up to this time it has definitely been worth the time and trouble involved.

DEVONIAN CATALOGUE UNITS ALREADY ISSUED

Group	*Date*	*No. of Cards*
Ammonoidea	1936	50
Beyrichiacea	1937	106
Fenestrellinidae	1938	251
Graptolithina	1939	13
Eurypterida	1939	16
Conocardiidae	1942	34
Leperditacea	1942	19
Thlipsuridae	1945	83
Auloporidae	1947	114

A CLEARING HOUSE FOR MICROFOSSIL LITERATURE AND SPECIMENS

By BROOKS F. ELLIS
U.S.A.
(Communicated by M. P. White, U.S.A)

FOR more than two hundred years men have been studying small fossils and recording their findings in published papers. Practically every civilized country in the world has had its quota of students of microscopic fossils, who, for the most part, wrote in the language of their fatherland and published in its journals. While these papers have had as good distribution as those of any other group, nevertheless it is true that extensive collections of the literature are to be found in only a few of the largest libraries. In the past, consequently, only a few advantageously located workers have had access to a major portion of the world's literature on this group.

Even where it has been available, the literature has not provided a smooth high-road to understanding. Growing up as it has, in many different countries and centres, it reflects a multitude of different methods, viewpoints and philosophies. In the past, barriers of language and distance have been very effective in isolating workers from one another. Small wonder then that the literature is confused, filled with claims, counter-claims, and duplication, and that it reflects a general disregard for the rules of nomenclature.

The writer had his first serious introduction to this situation more than twenty years ago, and was so impressed with the need for greater availability and system that he started to compile a catalogue for one group, the foraminifera. About three years later he was joined in this work by Miss Angelina Messina, and the two, aided by large federal grants, carried the project through to completion and publication in 1940.

The *Catalogue of Foraminifera* was published by the American Museum of Natural History as a report on Official Project No. 65. 1. 97. 21 W.P. 16 conducted under the auspices of the Work Projects Administration, and as originally issued, consisted of thirty volumes of about 1,200 pages each. It contained pertinent data on about 20,000 genera and species of foraminifera. This material was treated objectively, in that it was the editors' policy to present facts rather than opinions. The editors commented on the data only when such comment seemed necessary to a clearer understanding.

Genera, species and varieties that are generally accepted as foraminifera were included. Each was presented under the name originally applied to it by its author, provided this name was Linnaean and was accompanied by a description, indication, or definition. Names that have been suppressed as synonyms by later authors were included, as well as homonyms and some names which might be considered invalid according to the 1931 revision of the law of priority.

Each genus, species and variety was treated as a unit. These units were arranged alphabetically by genera, alphabetically by species within each genus, and alphabetically by varieties within each species. The index is arranged in the same manner and cross-referenced to indicate taxonomic changes.

The generic units included synonymy if given by the original author, the original reference, a transcript of the original description, the type species as designated by the original or subsequent authors, and a chronologically arranged list of additional references to the genus in the literature. Specific, subspecific and varietal units included synonymy if given by the original author, type reference, type figure, type description, type level, type locality and the depository of the type specimen. A chronologically arranged list of additional references was also given.

Finally, a selected bibliography and an index to taxonomic changes were part of the Catalogue as issued. An index to synonymy according to authors was also planned, but this, and several thousand units in preparation at the time the war interrupted the work, had to be omitted.

Each of the thirty volumes was bound in a specially constructed ledger-type post-binder. This was to permit rearrangement and to provide for the insertion of additional units as they became available.

On completion of the thirty volumes, the American Museum of Natural History established a Department of Micropaleontology to distribute the Catalogue to subscribers, to keep it up to date and to act as a general clearing-house for both literature and specimens. Since Museum funds were not available to finance the activity, it had to be maintained on a self-supporting basis. Those who wished to secure the Catalogue became subscribing members of the Department. Membership also entitled each subscriber to receive annual supplements and other services, and obligated him to pay annual dues. Two classes of membership were made available initially to subscribers, and about one-third of the edition of 330 Catalogues was distributed to these two groups combined.

The war years were lean and difficult, with many subscriptions suspended and few new ones added. As a result, the staff was reduced to two persons and work correspondingly slowed down. Little could be done toward cleaning up the back-log of units omitted from the original Catalogue; work on the index to synonymy was at a standstill, and even current literature could not be covered adequately.

With the coming of peace, however, the situation improved rapidly. Many new subscriptions were added and suspended ones revived. Finally, generous grants from several large oil company members have made it possible to expand the staff to ten permanent and two temporary members, and to improve the working facilities greatly.

Rapid progress is now being made toward bringing the Catalogue up to date. It is estimated that all of the units originally omitted from the Catalogue, as well as the accumulation of recent units not yet included in the supplements, will be processed and issued in about two and one-half years. At the same time, work on the various indexes, including the index to synonymy, is going forward. The depository of types and faunas is growing rapidly and as soon as it is sufficiently representative, a lending and exchange service will be established.

In addition to the depository, the Department has a library which includes practically all papers on foraminifera and about half of those published on ostracoda, and, in addition, card indexes to synonymy, to geologic and geographic distribution, to genera and species, to authors, and to depositories of type material of foraminifera. The Department also has very extensive files of photographs of plates and text-figures of foraminifera. A photostat service is maintained for members, and the Department owns and operates its own offset printing plant. Facilities for sectioning and photographing microfossils are presently being installed.

These services and resources are available to subscribing members, of which there are now three classes, namely, Continuing, Associate and Corporate. The first of these is reserved for educational institutions, while Government agencies, such as Surveys and Bureaus of Mines, are restricted to Associate membership. Corporate membership is required of all companies and business organizations subscribing to membership in the Department. All classes of members receive the Catalogue of Foraminifera and the supplements thereto as a basic benefit.

The Department now has 127 Continuing, 12 Associate, and 69 Corporate members. Included in this membership are most of the large universities of the world, many of the major museums and research institutions, and practically all the large oil companies.

Although the Department is self-supporting, it is nevertheless a part of the general organization of the American Museum, and its scientific personnel is an integral part of the scientific staff of that institution. Its activities are directed by a Chairman who in turn is responsible to the Director of the Museum. A Board of Advisers, composed of eminent geologists and micropaleontologists, aid and

advise the Department in matters of finance and also in developing its program of service to micropaleontologists.

Still another factor is needed, however, if the Department is to be truly successful. This factor is the co-operation of all persons engaged in work in this field. One practical way in which authors can materially aid the work of this Department is by sending in topotype materials and reprints of their papers as soon after publication as possible. Another way in which micropaleontologists can help is by calling our attention to errors and omissions in the Catalogue. Finally, all are urged to criticize the shortcomings of both the Catalogue and the Department and to suggest ways in which both can be improved. Only thus can we grow and finally reach the full stature of usefulness envisaged for this undertaking.

INTRODUCTION TO " PLANCHES INÉDITES " OF ALCIDE D'ORBIGNY

Par M. LYS

France

ABSTRACT

It is indispensable in palaeontology to refer to the original material; many species of foraminifera were created, figured and mentioned by Alcide d'Orbigny without ever having been confirmed or validated by any kind of publication. Fornasini was the first to endeavour to remedy possible confusion in determination when he published the original outlines of " Planches Inédites." Heron-Allen some time later took up the plan again when he published facsimile reproductions of a few plates. I now propose to publish in parts, a new *in extenso* edition including the original outlines supplemented by explanations and personal notes relative to each individual species. A drawing is never as reliable as one would want it to be but here the personal remarks of the author fortunately reveal the latter's full intentions. It should be recalled that d'Orbigny used his manuscripts as a sort of determining formula, at least up to the time of his systematic publications after his return from South America.

It is of some interest and importance to compare the " Planches Inédites " in the light of other data such as his Catalogue of Species and especially his collections which are kept at the Museum of Natural History in Paris. Cross-checking is then rendered possible, and this has been the motive in planning such a publication following that of d'Orbigny's card index, the original of which is housed at the " Institut du Pétrole " in Paris, where each of the index-cards carries the reproduction of the holotype or of a topotype together with the corresponding illustrations given of the same by the author, either in his published works or in his manuscripts.

DES documents connus sous le nom de Planches Inédites, existent au laboratoire de Paléontologie du Museum d'Histoire Naturelle de Paris.

Ce sont des dessins d'Alcide d'Orbigny qui étaient destinés à être reproduits pour illustrer son Tableau Méthodique de la Classe des Céphalopodes. Ces précieux fascicules ont connu des fortunes diverses:

d'Orbigny, dès l'âge de onze ans, se lance avec passion dans l'étude des foraminifères; il examine à la Rochelle les échantillons de sables de plage des environs que lui procure son père, des matériaux de Rimini, des sables de Corse et de nombreux prélèvements des mers lointaines que lui confient des amis, voyageurs ou marins.

Ce labeur acharné de classement, de discrimination s'accompagne d'observations et surtout de dessins un peu maladroits au début, mais dont la perfection est vite atteinte.

Désirant se documenter aux sources, il arrive à Paris en Avril, 1825; il entre aussitôt en contact avec de Férussac; il élargit ses horizons: il " découvre." Il visite les collections de Defrance, de Lamarck, il complète sa documentation et sept mois à peine se sont écoulés qu'il publie les premiers résultats de ses observations sur un groupe zoologique ignoré de tous. Il présente son Tableau Méthodique à l'Académie des Sciences, illustré de quelques planches puisées dans ses dessins. Sa conception des foraminifères est si claire que vingt ans plus tard il n'apportera que quelques retouches.

Dès la Rochelle, il songe à matérialiser ses vues, à mettre à la portée de tous l'étude de ces êtres microscopiques et prépare les livraisons de ses modèles en plâtre; les Planches illustrées du Tableau Méthodique formeront les premières ébauches imprimées, et, sous l'impulsion de son maître de Férussac, il envisage de publier in extenso les figurations *retouchées* et *coloriées* de ses 300 espèces créées en 1825 (publiées en 1826). C'est sous cette forme qu'il entend réaliser un " Prodrome " qui entrerait dans le cadre des Monographies du baron de Férussac. On peut contester l'exclusive originalité de ses espéces, Soldani notament lui ayant fourni des bases précieuses, mais il a intégré le magma

des ouvrages de son illustre prédécesseur, pour en faire une classification rationnelle, critique et linnéenne. Les membres de l'Académie des Sciences eurent le loisir d'admirer un ensemble de 73 planches cadrées, coloriées au lavis avec légendes et numérotation d'espèces se rapportant à celle du Tableau. Il restait encore environ 80 planches à achever au lavis puisqu'elles étaient déjà esquissées au crayon. Elles ne le furent jamais. Ce que Berthelin a légué à Fornasini ne représente que le calque des esquisses-plume de chaque espèce à partir desquelles d'Orbigny réalisa ses planches définitives.

Je reviendrai sur le détail des divers types de planches, mais j'ai voulu montrer que la pensée d'Alcide d'Orbigny était nettement définie et qu'il suivit son idée première jusqu'à son départ en Amérique.

D'un esprit remarquable doué d'un sens pratique assez poussé, il aimait concrétiser l'abstrait et il faut admirer sa conception première des modèles, l'exactitude de ses dessins, le perfectionnement progressif de ses premières esquisses qu'il n'hésita pas à refaire avant de dégager les caractères de l'espèce et même ses ébauches de diagrammes de Miliolidae.

J'insisterai enfin sur son mérite d'avoir pu non seulement extraire des types, mais dessiner, tant l'ornementation que les caractères buccaux, à l'aide d'un matériel optique vraiment primitif et les critiques sont déplacées qui reprochent à d'Orbigny de n'avoir point trouvé telle ou telle espèce dans un sable de plage ou fossile.

Faut-il regretter la proposition qu'on lui fit d'entreprendre un aussi vaste périple en Amérique Méridionale (Amérique du Sud)? Un peu pour les Rhizopodistes, car il laissa un travail remarquable inachevé, mais la profusion de collections et l'observation in situ furent de la plus haute importance pour les naturalistes, car il enrichit considérablement leur patrimoine scientifique.

Il accepte avec empressement ce poste de " voyageur " et parcourt l'Amérique de 1826 à 1833; il en ramène des matériaux originaux abondants, mais ne les mettra en valeur sous forme de publications, en ce qui concerne les foraminifères, que six ans après, en 1839, en même temps d'ailleurs que des matériaux des Iles Canaries et de l'Ile de Cuba. Son ardeur ne se polarise plus alors uniquement sur les Céphalopodes et les foraminifères, elle embrasse de multiples groupes animaux (tels les Bryozoaires, les Polypiers, les Mollusques, etc. . . .).

Les ouvrages publiés en 1839 sont d'un intérêt remarquable et de nombreuses espèces nouvelles y figurent; grâce à cela, il est possible de saisir les filiations respectives et les parentés entre certaines de ses espèces de 1826 en les comparant à celles qu'il figure cette fois.

Mais d'autres préoccupations se font jour; il s'intéresse de plus en plus à la stratigraphie, délaissant les faunes des mers actuelles dont il a tiré à peu près le maximum, il recherche les notions de corrélation et de faciès et il s'attaque un des premiers à un problème de corrélation stratigraphique grâce aux foraminifères. Le matériel est à sa portée, il étudie la microfaune de la Craie du Bassin de Paris, il est l'un des premiers à honorer de ses ouvrages les Mémoires de la Société Géologique de France.

Malgré l'abondance de ses travaux, il ne renonce pas à l'idée de son Prodrome, il complète ses planches en découpant les épreuves de ses ouvrages sur Cuba et le Bassin de Paris.

On lui envoie sans cesse des matériaux et notamment ceux du Bassin de Vienne; il en accepte l'étude, séduit sans doute par la magnifique conservation des espèces, leur abondance et leur beauté. Elle lui permettra de couronner sa carrière de micropaléontologie en produisant un ouvrage remarquable: il décrit plus exactement des espèces de 1826 (provenant du Miocène de Dax ou des environs de Bordeaux), en crée de nouvelles, se référant chaque fois par comparaison à des espèces antérieures ou contemporaines, et il ébauche plus explicitement les notions de faciès.

Il reprend l'oeuvre entreprise de la " Paléontologie française " et son Prodrome ne sortira manuscrit en 1847 (publié de 1850 à 1852, par suite de circonstances politiques) que sous forme de dictionnaire et le travail gigantesque qu'il avait prévu initialement avec illustrations, ne sera jamais achevé, d'autant qu'il n'y recense que les espèces fossiles.

Les Planches ne se compléteront même pas des découpages des ouvrages de l'Amérique Méridionale et des Canaries; ceux-ci se retrouveront, on ne sait par quelle circonstance, à la Rochelle, avec d'autres esquisses inédites complétant la documentation originale d'Alcide d'Orbigny. Les figures de Vienne ne sont pas découpées, elles restent en planches à la fin des documents inédits du Musée de la Rochelle.

S'il avait eu le temps d'achever son plan, que d'erreurs n'eut-il pas évitées? Tant d'espèces de son Tableau Méthodique demandaient à être illustrées (et elles l'étaient) mais pour des privilégiés ou des disciples de son entourage: Defrance, Cuvier, Guerin-Meneville surtout, qui illustre le " Règne Animal " de Cuvier et utilise les figurations inédites des Planches, confiées par d'Orbigny; il en extrait 22 espèces qui composent les planches 2 et 3 de l'Iconographie des Mollusques.

A sa mort, toute sa bibliothèque est mise en vente et le Museum de Paris se rend acquéreur de beaucoup de manuscrits parmi lesquels les Planches illustrées; mais d'autres lui échappent et je ne vois pas d'autre explication à la dissociation des dessins originaux dont le Musée de la Rochelle possède une partie, la moins importante il est vrai, de même technique, cadrés, numérotés, signés Alcide d'Orbigny, et qui étaient destinés à figurer au Prodrome. Nous y retrouvons aussi les figurations découpées de ses ouvrages des Canaries, de l'Amérique Méridionale, les figures de Guerin-Meneville, et les minutes originales du Bassin de Vienne, non découpées.

Ceci forme donc un tout, dont les éléments se complètent entre eux; il serait du plus grand intérêt de regrouper des documents aussi précieux; les paléontologistes n'en seront que plus heureux.

d'Orbigny n'a évidemment pas dessiné, figuré, créé des espèces en aussi grand nombre sans consigner de notes s'y référant; au même titre les manuscrits et ses ouvrages ne purent être retrouvés.

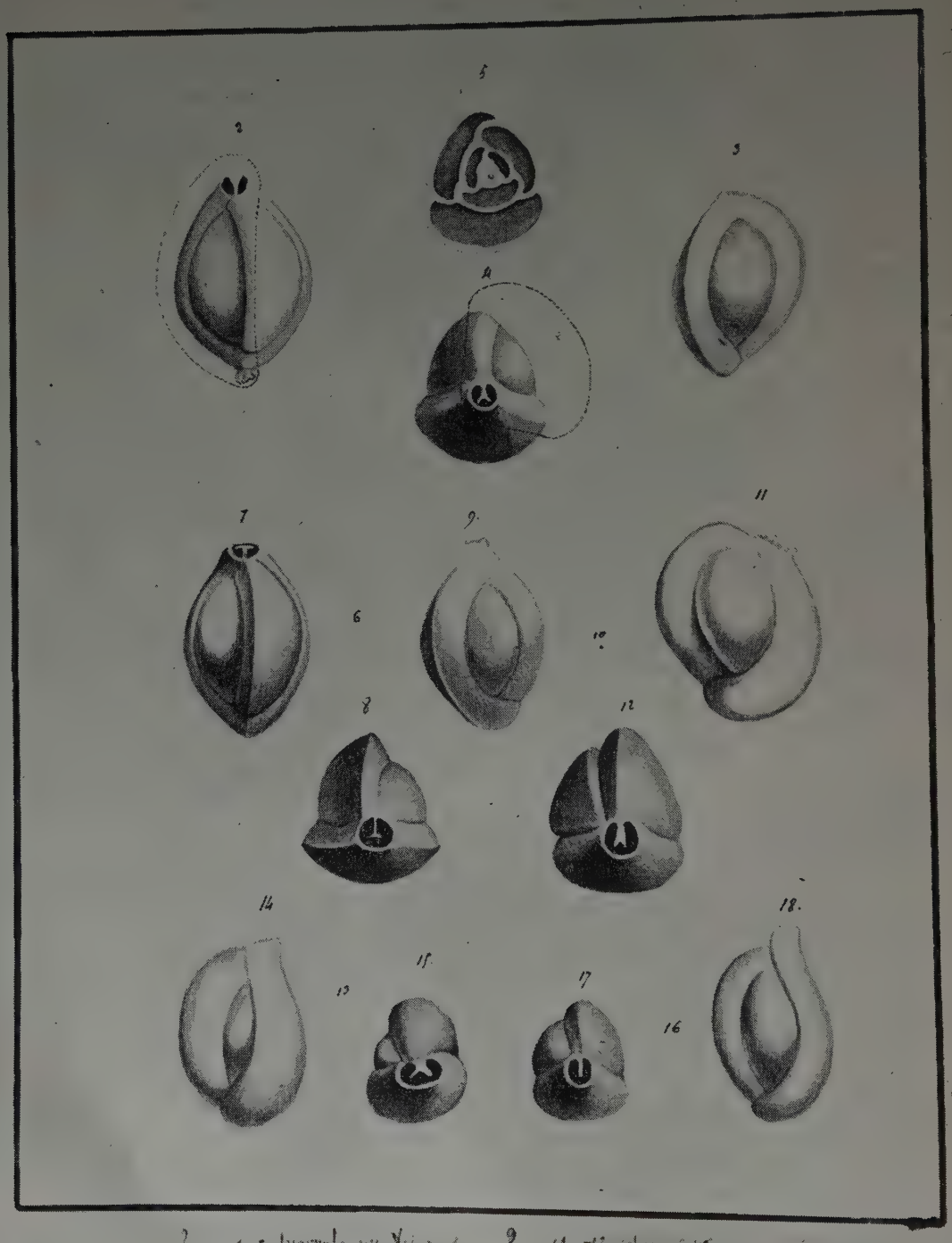
Le catalogue de la vente aux enchères publiques fait ressortir une série de manuscrits et de notes; peut-être ont-ils été dispersés ou acquis par son frère au même titre que le complément des Planches, qui par la suite en fit don à la ville de la Rochelle. Nous avons appris par les Annales de la Société des Sciences de la Rochelle, qu'Alcide d'Orbigny ne fut guère reconnaissant à sa patrie d'origine et qu'il n'y fit plus aucune apparition depuis 1826. Il ne leur laissa sans doute, ni ne légua aucun document ni collection.

Quelques années plus tard, Terquem découvre les précieux manuscrits et les collections; il en relate la découverte dans son ouvrage sur le Pliocène de l'île de Rhodes, il entreprend de les mettre en valeur, de classer méthodiquement les petits tubes contenant les types originaux de d'Orbigny. Soyons lui redevables d'avoir tiré de l'oubli ces reliques et d'en avoir restauré la plupart. Regrettons toutefois qu'il n'y ait pas apporté plus de méthode et qu'il n'ait pas toujours distingué les matériaux de d'Orbigny des siens propres; il a négligé aussi de ranger complètement les échantillons et il m'arrive de retrouver des types signalés comme perdus. Il utilise largement les précieux fascicules pour ses déterminations; leur rapporte des références dans sa synonymie des espèces de Rhodes et de l'Eocène du Bassin de Paris, mais son interprétation des espèces est très discutable sinon fausse, et il eût été préférable dans l'intérêt de tous, qu'il ne crée pas ces confusions. Son intention première était de publier les fascicules des " Planches Inédites " un à un, (cf. Préface à l'Ile de Rhodes, 1878, p. 3) mais les moyens financiers et l'ampleur de la tâche le firent reculer; il n'a fait que confirmer ses vues en 1882.

Berthelin, à sa suite, s'occupe plus positivement de ce problème. La photographie n'était pas encore sortie du domaine théorique et avec une patience et un scrupule remarquables, il fixe sur calque chaque esquisse-plume. Il consigne exactement toutes les indications susceptibles d'éclairer le spécialiste, telles que provenance, numéro, etc. Il rassemble le tout dans un volumineux dossier accompagné d'un manuscrit, et avant sa mort, lègue l'ensemble â son collègue Fornasini en le priant de l'utiliser au mieux.

Schlumberger n'ignore pas lui non plus l'existence des Planches; il s'en servira largement et y puisera ses références, à la base de ses monographies sur les Miliolidae.

Il appartient alors à Fornasini de réaliser le désir de Berthelin: diffuser ses documents ignorés de tous, sous forme d'études critiques et de monographies. Il y consacre dix années entre 1897 et 1908, reprenant même en 1902 l'étude du gisement de Rimini, essayant de distinguer les espèces proprement actuelles des espèces fossiles des sables de plage en provenance des collines pliocènes voisines. Il ne m'appartient pas de discuter l'œuvre remarquable de cet auteur; si quelques critiques existent, je les signalerai dans la rubrique " Observations " du fichier Alc. d'Orbigny dont la présentation a été annoncée (Lys, M. & Sigal, J., 1947), et dans la publication intégrale et originale des Planches Inédites.



Fac-similé (Réduction ¾) de la planche définitive, fascicule " Triloculina," Pl. I.

Heron-Allen (1917), quelques années plus tard, reprend la question " Alcide d'Orbigny " sous tous ses aspects. Il en donne une biographie détaillée, remontant aux sources et nous dévoilant même le cadre de l'intimité familiale. Tous les travaux y sont analysés; il tente quelques considérations critiques sur la valeur de l'œuvre paléontologique et sous forme d'appendices, donne quelques précisions chronologiques. Cet excellent panygérique est un guide précieux, très documenté. Heron-Allen consacre quelques pages (pp. 33–37) aux Planches Inédites et dans un louable souci de vérité, nous reproduit un facsimilé en réduction, trichrome, d'une planche définitive du fascicule *Rosalina* (op. cit., pl. VIII) et une autre du fascicule *Rotalia* (op. cit., pl. IX). C'est sous cette forme que d'Orbigny conceivait la présentation de son " Prodrome " à l'Académie des Sciences d'abord (où il produisit 73 planches de ce genre complétement achevées en lavis couleur), au service de la Paléontologie ensuite. Il était dans l'intention d'Heron-Allen de publier la totalité des Planches Inédites sous cette forme; la guerre de 1914–1918 ne lui a pas permis de réaliser un si beau projet et les moyens matériels lui ont-ils fait défaut après ces évènements?

Je souhaite que ce projet qu'ambitionnait ce maître regretté ne rencontre plus d'entraves et mette un terme aux incertitudes et aux inexactitudes qui planent sur la validité des espèces créées par d'Orbigny au cours de sa féconde et prodigieuse carrière.

Les fascicules des Planches Inédites se trouvent, comme une relique précieuse, conservés dans leur état original, admirés et consultés périodiquement par les spécialistes français et étrangers.

J'ai tenté un effort de plus que mes prédécesseurs; j'ai entrepris de revoir systématiquement l'ensemble de la collection Alcide d'Orbigny; cellules, flacons, etc. . . . repris ou non par Terquem et d'en compléter la valeur le plus exactement possible par l'examen de tubes délaissés ou le prélèvement dans les flacons d'origine de types sous differentes formes (topotypes, lectotypes, neolectotypes, etc.). Les manuscrits surtout ont été analysés: catalogue dressé par d'Orbigny pour ses espèces, registres originaux. Les Planches Inédites ont fait l'objet d'un soin particulier: chaque fascicule a été disséqué. Il existe divers modèles de planches (six selon Heron-Allen, pp. 35, 36); je les énumère à nouveau car des observations s'y réfèrent et je tiens à signaler que j'ai employé* une numérotation arbitraire des planches qui, sans être définitive, pourrait être adoptée, ceci dans un but pratique.

1. Planches définitives, dont les figures sont au crayon mais coloriées délicatement au lavis.

   Les espéces sont numérotées dans une légende, le nom du genre auquel elles appartiennent est calligraphié en haut de la planche. Ces planches sont cadrées et je leur ai affecté un numéro d'ordre en chiffres romains (Ex. I, II, III, etc.)—(voir pl. I ici).
2. Planches définitives, mais que d'Orbigny n'a pas achevées; elles peuvent être en partie coloriées, mais souvent le dessin n'est qu'à peine esquissé en traits peu accusés.

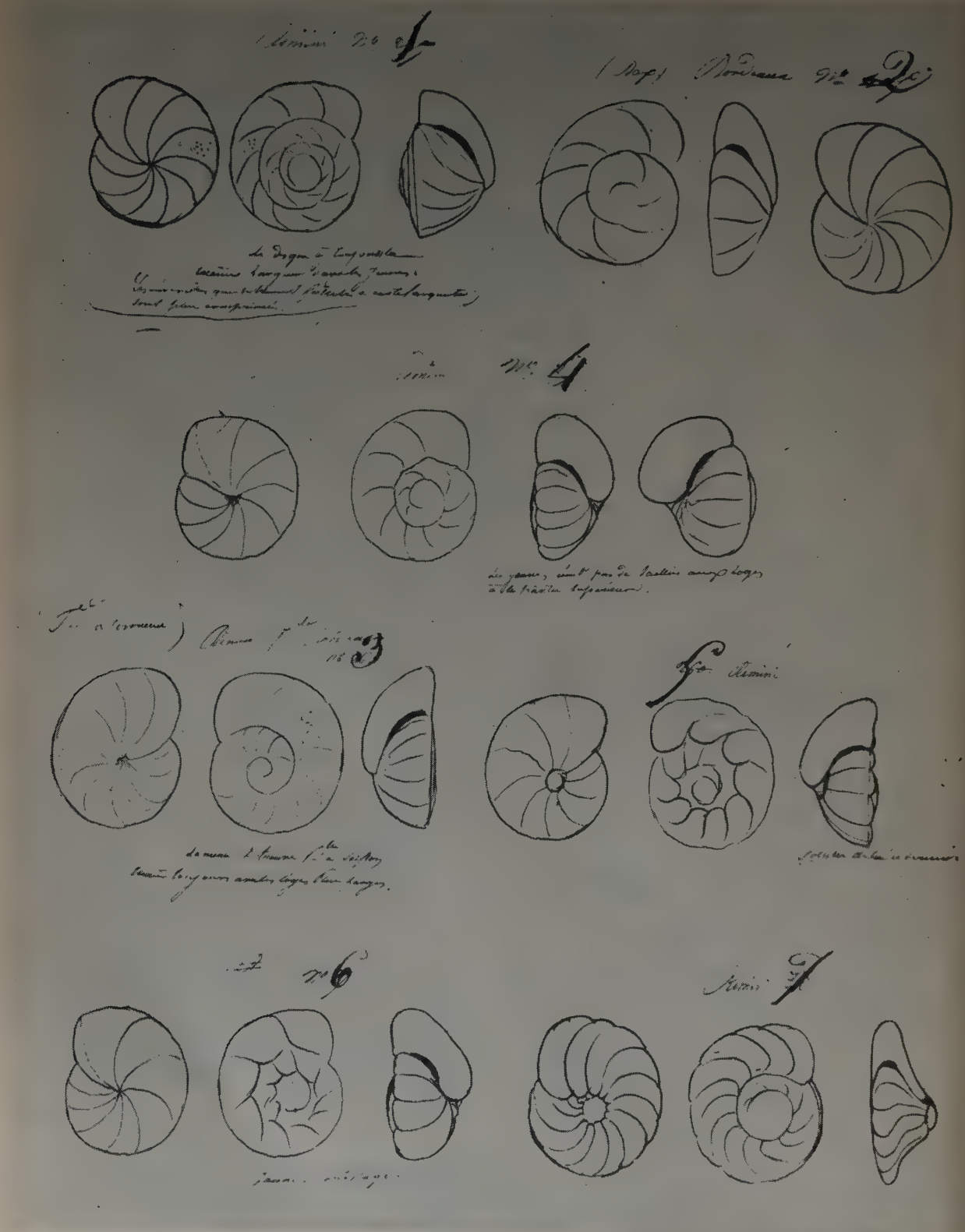
   Légende et cadre sont comparables aux précédentes et je les ai confondues pour la numérotation.
3. Planches comprenant des dessins esquissés au crayon, puis retracés à la plume encre de Chine ou sépia par Alcide d'Orbigny.

   Heron-Allen (op. cit., p. 36) fait remarquer, très à propos, que l'ornementation du test est partiellement représentée (elle le sera entièrement et exactement dans les planches définitives); tels sont les originaux scrupuleusement respectés par Berthelin et transmis à Fornasini. Ces dessins devaient être primitivement esquissés au crayon sur des feuilles d'un autre registre (classification par gisements?). d'Orbigny les découpa et les réunit par genres, leur affectant une identité spécifique et une numéro correspondant à un catalogue personnel que j'ai tenté de reconstituer (il comprendrait environ 500 espèces dont les doubles ne sont pas exclus).

   J'ai affecté à ces planches " provisoires " un numéro d'ordre en chiffres arabes (Ex. 1, 2, 3, etc.)—(voir pl. II ici).
4. Des planches cadrées et numérotées comprenant des dessins à la plume sépia affectés chacun d'un numéro en principe identique à celui que l'on observe sur les autres planches (pl. 1, 2, etc.). J'insiste sur le terme " en principe " car de nombreuses inexactitudes sont relevées que j'ai rectifiées

* C'est celle que j'ai adoptée pour le fichier d'Orbigny en cours de parution.

PLATE II



Fac-similé (*Réduction* $\frac{3}{4}$) *de la planche provisoire du fascicule* " *Gyroïdina*," Pl. 1.

le mieux possible étant donné l'interprétation parfois fantaisiste de l'espèce (je rappelle toutefois ce que j'ai dit au début concernant le matériel optique de l'époque). Le numéro de la planche, que j'ai repris, ne correspond pas à des figures de Soldani comme le pense Heron-Allen (op. cit., p. 36) mais consécutivement à une remarque de d'Orbigny (cf., fascicule *Gyroidina*, pl. G_1 en bas) les genres sont affectés d'une lettre. Voici des exemples:

Gyroidina = Planches G_1, G_2, G_3
Truncatulina = „ C_1, C_2, C_3

Grâce à cela, il est possible de reclasser parfois exactement une figuration aberrante.

Ce sont les planches dont parle Heron-Allen qui sont notées " Coquilles libres " avec indication de provenance.—(voir pl. III ici).

5. Il existe enfin des planches non cadrées, sans autre indication que le numéro et la provenance; les figures sont à la plume sépia rehaussée parfois d'un lavis de couleur.

Je leur affecte un numéro arbitraire 0, 00, 000, etc., et leur attribue une place intermédiaire entre les dessins des planches définitives et les esquisses.

Le soin apporté à leur confection est tout relatif.

Je n'ai pas cru devoir classer ni reproduire les planches comprenant les figures découpées d'ouvrages de documentation bibliographique ayant servi à d'Orbigny pour ses déterminations (tels que le Dictionnaire des Sciences Naturelles, l'Encyclopédie Méthodique, etc.). Ceci ne fait donner qu'un argument probant sur l'érudition très poussée et la conscience avec laquelle il fondait son nouveau systéme de classification. Les documents de la Rochelle, bien plus abondants, formaient une sorte de fichier ou de " vade mecum " pour le jeune Alc. d'Orbigny.*

D'autres figurations prennent place au même titre; ce sont celles du Tableau Méthodique, de l'île de Cuba, du bassin de Paris et non du bassin de Vienne comme Heron-Allen l'indique par erreur (fausse indication manuscrite dans les fascicules *Gaudryina* et *Verneuilina*).

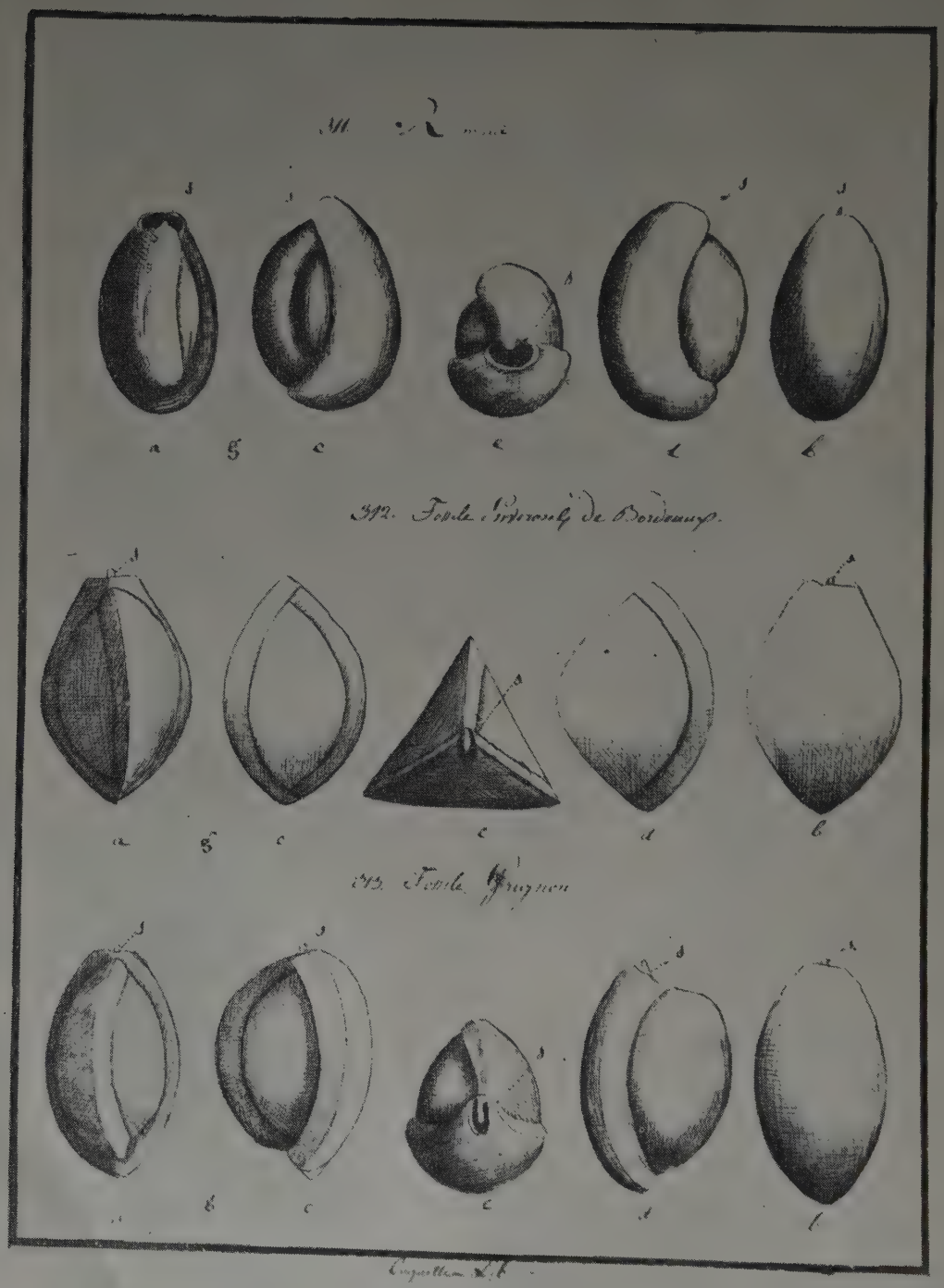
L'ensemble des fascicules correspond au nombre des genres créés ou reconnus par d'Orbigny, et le nombre des planches s'établit aux environ de 300, comme l'indique Terquem.

Parmi elles, 73 étaient terminées
80 étaient inachevées
qui devaient fournir un ensemble de planches définitives illustrées et coloriées.

Il me reste quelques observations à ajouter sur la paternité que peut revendiquer Alcide d'Orbigny sur cet ensemble de dessins et ceci pour dissiper toute équivoque entre Charles d'Orbigny, son père, et Alcide d'Orbigny. Il est incontestable que le père non seulement stimula son fils dès sa jeunesse, mais aussi l'initia à l'étude des " Céphalopodes microscopiques "; il observa beaucoup et dessina sans doute les individus microscopiques, au cours de ses recherches sur les Polypiers et autres groupes animaux. Mais, et il le dit lui-même, en 1819 (cf. Heron-Allen, 1917, p. 7) sa vue baissait beaucoup et il " empruntait " les yeux de son fils pour dessiner; son intention etait de différer et non de renoncer à dessiner.

Il est à l'origine de la brillante carrière de son fils, et certes pas étranger à la méthode de classification, ayant distingué plus de cent espèces et variétés dans des sables d'Angoulins et de l'anse de l'Aiguillon près de la Rochelle. Heron-Allen est à peu près formel sur le fait que les dessins sont du fils (op. cit., p. 6) et je partage son avis en me basant sur les faits suivants: les dessins des planches dont j'ai parlé au § 4 (pls. N_2, C, G, etc.). résultent d'abord d'une observation moins minutieuse, manquant de précision dans les caractères du test (ornementation et même agencement des loges); ils se rapportent en outre à des prèlèvements sur les côtes de France et spécialement des environs de la Rochelle, out de gisements fossiles des environs de Bordeaux et de Paris. Celui de Rimini tient une grande place. Nous en connaissons l'origine et spécialement de Rimini, communiqués par Soldani lui-même à Fleuriau de Bellevue, ami de la famille d'Orbigny. Je n'exclue pas le classement de ces planches et la numérotation par le père, mais aucune détermination spécifique n'est précisée;

* Ceci fera l'objet d'une publication ultérieure, parallèlement à celle des Planches Inédites.



Fac-similé (*Réduction* $\frac{3}{4}$) *de la planche cadrée fascicule* " *Triloculina,*" Pl. U $_3$

seule la catégorie est indiquée par une lettre à laquelle le fils affectera une nomination générique. Charles d'Orbigny employait en effet les termes de Lamarck et de Blainville; " Lenticulines, Rotalies, Discorbes, Spirolines, etc."

Telle est l'ébauche initiale des Planches Inédites qui servait de répertoire de détermination. S'en servant à l'occasion Alcide d'Orbigny refait une esquisse (cf. types des pls. 1, 2, 3, etc.) d'après nature et reprenant la provenance, y ajoute des observations au crayon, rectifie des détails à la lueur d'autres gisements qu'il mentionne, reprend le numéro initial (celui d'un catalogue dont j'ai parlé plus haut), et reclasse le tout par genres, fixe à l'encre ses traits; il regroupe par affinités, et selon l'ordre duTableau Méthodique, modifiant en conséquence la numérotation en accord avec ses espèces, les dénomme en français d'abord, en latin ensuite, suivant les régles linnéennes.

Le travail est prêt pour illustrer la planche définitive (cf. type pl. 1, 2), chaque dessin est reporté scrupuleusement et d'une main assurée au crayon, idéalise parfois, et aussitôt coché sur l'esquisse qui lui a servi de modèle. Ce sera le type de planche définitive que d'Orbigny dans ses loisirs s'amusera à colorier au lavis.

Il se doit de présenter à l'Académie en 1825, le maximum de planches, il ne finira qu'un fascicule, celui de *Nodosaria* qui représente le premier genre de la première famille de sa classification, et présentera au moins une planche par fascicule pour illustrer chacun de ses genres.

L'illustration des Planches du Tableau Méthodique est prise très exactement à partir de ceux-ci. Guerin-Meneville se charge d'illustrer le Règne Animal de Cuvier; il sollicite de d'Orbigny quelques figurations. C'est d'Orbigny lui-même qui lui indique les espèces les plus aptes à être reproduites (d'une croix encore visible sur les Planches). Ce seront les deux occasions que se présenteront pour diffuser la figuration de ses espèces du Tableau, mais qui représentent 32 espèces d'une part, et 16 de l'autre, en comparaison du reste (552); il faut tenir compte de la publication des modèles (100 espèces).

Ayant relevé quelques rares erreurs dans le report des noms spécifiques sur les planches définitives, je suppose que celles-ci furent achevées à la hate avant le départ pour Paris et le " grand voyage en Amérique." La surimpression de localités dans les légendes n'est pas étrangère sans doute à Berthelin.

J'ai tenu à indiquer rapidement le processus d'établissement des Planches Inédites pour rectifier l'hypothèse d'Heron-Allen (op. cit., pp. 35, 36) selon laquelle les dessins que j'ai appelés " premières ébauches " seraient dérivés des esquisses repassées à l'encre. Ce serait une véritable régression des aptitudes artistiques de d'Orbigny!

Aucune date n'a été donnée pour les Planches Inédites; j'ai exposé suffisamment la chronologie relative sans être tenu d'y revenir. Si l'on veut être exact, leur établissement s'échelonne de sa jeunesse à sa mort, mais elles étaient prêtes dans leur majorité en 1825, à la présentation à l'Académie. Des retouches, des compléments y furent apportés un peu avant son départ en Amérique en juin 1826, et à son retour, il se consacre plutôt à compléter ce document avec des publications. Tenons-nous donc approximativement à la date du Tableau Méthodique, c'est à dire à celle de 1826. Je n'en tiens pour argument décisif que le fait de ranger ses fascicules sous la rubrique de tête " Céphalopodes Foraminifères " terme qu'il abandonne à son retour d'Amérique après les découvertes de Dujardin en 1835.

Admirons, en terminant, la sagacité et la précocité de notre maître en paléontologie pour nous avoir légué un tel ensemble alors qu'il venait d'atteindre à peine vingt trois ans!

Je me suis attaché à respecter le plus possible la pensée de d'Orbigny et à la faire revivre, essayant d'en dégager les idées directrices.

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A PROPOSAL THAT THERE BE A BUREAU OF THE INTERNATIONAL PALEONTOLOGICAL UNION

By S. H. HAUGHTON

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THE prime objectives of the original International Geological Congress Commission on Palaeontologia Universalis were to reproduce classic illustrations and to produce illustrations and annotated descriptions of all described fossil species, and were thus international in scope. A task of this nature could only begin to be accomplished with the active support of specialists of all nations and with the expenditure of large sums of money for which no provision was ever made. Some work on a national scale has been done, largely in the U.S.A. and in France, and the monographs of the Palaeontographical Society also fall into this category.

In the Report of the Fifteenth International Geological Congress (South Africa), it was stated that " a critical catalogue of fossils embracing all palaeontological genera is to be published and every volume is to embrace one or more families." At the Sixteenth Congress (Washington) a resolution was carried limiting reproduction to cards, type fossils and some others, and European faunas, and leaving the initiation of financial arrangements in the hands of Fallot. This resolution seemed peculiar, coming from a Commission on "Palaeontologia Universalis"; but it was probably influenced by arguments to the effect that North America could look after its own affairs and, in fact, was doing so as far as Devonian fossils were concerned.

What palaeontologists most desire, or should most desire, is a way of ascertaining whether forms which they are studying have been made known from their own country or from some other country and the relationships existing between their forms and those occurring elsewhere. Very few palaeontologists have a complete descriptive library, even in a limited field, at their disposal; and few have the opportunity of examining actual type or co-type specimens if these are housed in lands other than their own. Thus the " critical catalogue of fossils " mentioned by the Fifteenth Congress is a desirable ideal; but the publication of such a catalogue " embracing all palaeontological genera " would be so enormous an undertaking that, even if achieved, few institutions would be able to afford to purchase.

There are possibly several ways of overcoming the difficulties; but I would suggest one for consideration, which is based on (*a*) the comparatively limited requirements of individual palaeontologists, and (*b*) the advantages offered by microfilm technique. In outline it is as follows.

The International Paleontological Union should set up a permanent Bureau whose first task would be no less than the preparation of a card catalogue (or a catalogue on cards) of all described species of fossils, studied and annotated by specialists. The card for each species would be illustrated and would carry the original description of the species together with additions to or subsequent amendments of that description, as well as references to its literature. The cards would be arranged in zoological order and retained in the Bureau. Palaeontologists or institutions could then obtain microfilm copies of any cards they desired to have, at a fixed price; and it would not be necessary for such an applicant to have to pay for printed information concerning, say, a whole family when his only interest was in one or two genera. The Bureau would, of course, need a small permanent staff and accommodation for its work; and it would need to be assured of a permanent income. Possibly the International Paleontological Union should be made responsible for the Bureau's maintenance, and possibly the necessary funds might be obtainable from UNESCO rather than by contributions from individual States. States that are non-adherents of UNESCO might agree to contribute to the Union and thus take part in the Bureau's activities.

Such an undertaking would obviously need the co-operation of specialist palaeontologists, and it is probable that some if not all of them would require remuneration for what, in effect, would be a survey and a revision of each genus. An estimate of probable expenditure should, in my opinion, include such remuneration.

For the first decade or so, the Bureau's task would be heavy; but as time passed it would be lightened and ultimately it would merely have to keep pace with current palaeontological output. Individual palaeontologists would, there can be no doubt, be grateful for an arrangement through which they could obtain the information they require without having to maintain and search through a large number of publications, some of them rare or even unobtainable. In the smaller countries, such as my own, inability to obtain certain publications is a serious handicap.

This proposal is presented in a very rough form, and numerous details would have to be very carefully considered. Naturally, the suggested Bureau would have to be located near one of the bigger palaeontological libraries in Britain, France or the U.S.A.; and it would, to my mind, require a permanent Director and an Advisory Committee of the Union. The task to be performed is a tremendous one but unless the arrangements for carrying it out are on a sure foundation it should not be begun.

LA DOCUMENTATION PALÉONTOLOGIQUE : LE CENTRE D'ÉTUDES ET DE DOCUMENTATION PALÉONTOLOGIQUES FRANÇAIS

By J. ROGER
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ABSTRACT

I. *La nécessité d'une organisation de la documentation paléontologique* est démontrée par:—
l'évolution des méthodes, des buts et de la philosophie de la paléontologie;
les méthodes de travail pratiquées par les chercheurs;
les tentatives déjà faites, les voeux émis par les géologues et par les réunions internationales et les idées qui se dégagent de certains articles récents.

Pour faciliter le travail de détermination et assurer les progrés de la paléontologie, en aidant aux rapprochements des faits et des idées, il convient de réaliser une centralisation des documents.

II. *L'organisation, sous sa forme idéale et complète comprendrait:*—

(1) Un centre international avec:—
des fichiers: de renseignements, signalétiques bibliographiques et systématiques, illustrés;
des analyses d'articles et d'ouvrages et des traductions;
des collections de spécimens et de moulages.

La diffusion serait assurée par courrier, microfilms, communication, publication.

(2) Des centres régionaux.

III. La réalisation effective, au Laboratoire de Paléontologie du Muséum de Paris, depuis 1945, avec des moyens restreints, d'un *Centre d'Études et de Documentation paléontologiques* (*C.E.D.P.*), montre que ce projet n'est pas une utopie.

Il représente la continuation et l'amplification sur le plan officiel du Syndicat de Documentation paléontologique fondé en 1914.

Dans sa structure actuelle il comprend une section de documentation général et 17 sections pour la systématique. Les trois catégories de fichiers sont: renseignements (format 125 × 75 mm.), bibliographiques (même format), systématiques (même format et fiches illustrées sur 185 × 250 mm.). Ses collections de comparaison sont trés avancées.

Il fonctionne dans des locaux vastes, incomplètement amenagés et dispose comme personnel de 3 dactylographes et 4 scientifiques.

Il est proposé de faire du C.E.D.P. le siège de l'Union paléontologique internationale.

L'INTÉRÊT considérable d'une organisation méthodique de la documentation apparait de plus en plus dans le domaine scientifique en général et dans celui des sciences de la terre en particulier. Le plan d'une telle organisation sera ensuite présenté et la réalisation d'un Centre d'Études et de documentation paléontologiques au Muséum national d'Histoire Naturelle de Paris sera exposée.

I.—LA NÉCESSITÉ IMPÉRIEUSE D'UNE ORGANISATION DE LA DOCUMENTATION PALÉONTOLOGIQUE, afin d'assurer les progrès de cette science est démontrée par:

1.—L'évolution des méthodes, des buts, de la philosophie de la Paléontologie. Dans l'histoire de la Paléontologie à la période " des fables ", qui se prolonge jusqu'au début du 18° siècle, succède celle des collections et de la description. Ce sont les " cabinets d'Histoire Naturelle " du 18° siècle. Elle devient réellement une science quand, les fossiles étant incorporés dans le classification générale des êtres vivants, les successions des organismes dans le temps servent à étayer les théories transformistes. C'est la période " rationnelle ou morphologique "; c'est aussi la période philosophique. En même temps la Paléontologie devient de plus en plus le serviteur précieux des autres Sciences de la Terre, notamment de la stratigraphie.

Une nouvelle étape se précise de plus en plus depuis quelques décades en connexion avec l'évolution des autres branches des Sciences de la Terre. Les caractéristiques essentielles de cette période moderne me semblent être les suivantes:

(*a*) La liaison entre la Paléontologie et Stratigraphie, sur le plan pratique est de plus en plus étroite. Cela se traduit de façon heureuse par l'apport de matériaux nouveaux, la sollicitation de travaux et la considération d'éléments d'information variés. Cependant il résulte de ces rapports une sorte d'état de tutelle de la Paléontologie, que déplorent de nombreux chercheurs, ainsi qu'en font foi plusieurs publications récentes notamment aux États Unis. Il est bien probable que l'essor de la Paléontologie, en tant que discipline majeure, s'en trouve gêné.

(*b*) Le fait isolé, l'observation fragmentaire, ne sont plus suffisants. Cette remarque s'applique d'ailleurs à beaucoup d'autres domaines des Sciences d'observation. L'introduction des notions de statistique et des méthodes quantitatives, en pétrographie, en écologie, dans l'étude des groupes systématiques, etc., en est la preuve.

(*c*) Les observations atteignent une précision et une finesse qui vont en augmentant. Précision dans la situation géographique et stratigraphique des faunes. Précision aussi dans le densité des peuplements fossiles, dans la position des individus, dans leur répartition à l'intérieur du gisement. La finesse atteinte dans la description des échantillons conduit à de véritables " dissections " et même à des études de " paléohistologie."

(*d*) La caractéristique fondamentale parait être cependant l'introduction en paléontologie, et la mise au premier plan, de l'idée de vie. Progressivement la reconstitution de plus en plus complète des fossiles, dans leur aspect initial, avec les parties molles, conduit à rechercher le fonctionnement, la physiologie, des organismes disparus. La considération du milieu conduit à celle des associations. La paléontologie devient ainsi paléoécologie ou paléobiologie. Ainsi elle pènétre dans le cadre des sciences biologiques. Cette dernière caractéristique parait en réalité avoir entrainé les autres. Les synthèses d'ordre paléobiologique exigent en effet la nécessité de données multiples, précises, très exactes, fines, à la fois sur les êtres, sur la roche, sur la stratigraphie et la paléogéographie. Il convient de remarquer que les caractéristiques de cette étape " biologique " de la Paléontologie se sont esquissées sporadiquement tout au cours de son histoire. Il ne serait pas difficile de citer des auteurs anciens qui, déjà, sentaient cette orientation future de leur science.

L'orientation nouvelle de la paléontologie a, sur le plan pratique, des conséquences d'une importance primordiale.

Succintement il est possible d'en citer trois:

(*a*) élargissement considérable de la documentation dans plusieurs domaines. D'abord dans celui de la stratigraphie. Le paléontologiste se doit de prendre des informations précises non seulement sur le niveau auquel appartiennent les faunes qu'il étudie, mais il est indispensable qu'il pratique lui-même le terrain. L'examen des fossiles dans leur propre gisement fournit une foule de renseignements en vue des synthèses paléobiologiques. Il lui faut aussi atteindre une vue paléogéographique précise sur la région qu'il étudie. L'étude de la gangue, est la source de multiples indications, et de renseignements fondamentaux sur les conditions du milieu. C'est donc encore vers la pétrographie que le paléontologiste devra se tourner. Cependant c'est sans doute vers les sciences de la nature actuelle que l'élargissement du domaine d'information est plus net. Ce n'est pas seulement la systématique qui intéressera le paléobiologiste, mais aussi la répartition géographique et bionomique, c'est aussi l'anatomie interne. Les données de la biologie dans le domaine de la génétique et de l'évolution sont également necessaires.

Les informations qui paraissent actuellement sont d'ailleurs excessivement nombreuses. Citons quelques exemples. Les périodiques actuellement dépouillés par le Centre d'Études et de Documentation paléontologiques du Muséum de Paris sont au nombre de 2,000. Les termes stratigraphiques utilisés se multiplient chaque jour et un fichier en préparation en

renferme prés de 3,000. Dans le seul règne animal nous avons relevé près de 5,000 nouveaux noms de genre parus depuis 1940. On peut admettre qu'il y en a eu beaucoup plus de mis en circulation. Pour la période de 1940 à 1946 nous avons, sans chercher à être complet, trouvé 8,000 espèces nouvelles d'insectes.

Nous nous trouvons donc en présence d'une abondance de faits nouveaux, d'observations précises, bien précieux que nous laissons en partie se perdre faute de savoir organiser son utilisation. Il y a plus, la Paléontologie risque de se trouver ensevelie sous ces multiples données et le désordre risque de s'installer, notamment en systématique.

(*b*) Les ressources que les techniques modernes peuvent mettre à notre disposition doivent également être utilisées, si l'on veut obtenir à la fois précision et multiplication des observations. Il faut aussi chercher à combler les " lacunes " de la paléontologie que si souvent on nous reproche. On sait d'ailleurs les beaux résultats déjà obtenus par l'application de la " grinding method " ou par celle des rayons X.

(*c*) La détermination des fossiles apparaissait comme la fin même de la Paléontologie. Maintenant on réalise qu'elle ne doit être qu'une étape d'utilité pratique pour le stratigraphe, mais surtout le travail préliminaire indispensable aux études paléobiologiques.

Conclusion.—La Paléontologie découvre des horizons nouveaux sous la forme de Paléobiologie, mais cela entraine un besoin d'extension considérable en surface de ses informations, en faisant appel a des disciplines variées. En outre l'étude de son propre matériel demande une spécialisation de plus en plus étroite, pour permettre les observations précises, suivant les méthodes nouvelles. Il y a donc là une contradiction. Une organisation méthodique de la documentation apparait par suite necessaire.

2.—*Les procédés utilisés dans leur travail par les chercheurs* depuis longtemps et la situation actuelle des publications paléontologiques. Dans une communication à la Société géologique de France le 21 février 1916 (Cottreau et al. 1916) cinq géologues français soulignaient les difficultés rencontrées dans les déterminations, quant à la bibliographie par les paléontologistes. Celles ci n'ont évidemment fait que s'accroître. Il faudrait encore y ajouter les difficultés résultant de la recherche d'échantillons indispensables pour comparaison, exemplaires conférés, topotypes, etc. Les spécialistes parviennent à surmonter toutes ces difficultés. Ils recoivent les tirages à part de la majorité des publications se rapportant à leur groupe. Ils facilitent leur tâche en fabriquant des fiches, souvent avec figurations ou reproduction de figures. Ils se constituent des collections de comparaison. L'ensemble représente une grosse dépense de temps. Chaque génération recommence d'ailleurs la même opération d'apprentissage aggravée par toutes les publications nouvelles. Il faudrait donc que:—

(1) Le travail de mise sur fiche effectué par chacun ne soit pas perdu. Il est désolant de retrouver, enfouis sous la poussière des greniers, des fichiers résultant du labeur de nos prédécesseurs.

(2) des inventaires de collections et surtout des spécimens conférés soient réalisés, de façon aussi complète que possible.

(3) la centralisation des renseignements et leur tenue à jour méthodique soient réalisées, représentant également une grosse économie de temps. Ainsi que nous l'avons déjà signalé Roger (1946, 1946a, 1947) la difficulté d'embrasser l'ensemble des publications relatives à une question fait que, le plus souvent, l'auteur opère une sélection. Il arrive que les travaux paraissant en une langue étrangère qu'il connait mal soient négligés. On aboutit à une tendance " séparatiste " très fâcheuse. On conçoit les graves erreurs qui pourront entacher des conclusions biostratigraphiques ou phylogéniques par suite de l'omission d'une seule citation. L'absence de documentation suffisamment complète empêche de distinguer les voies dans lesquelles s'engage la Paléontologie et retarde d'autant ses progrès. Il serait facile de donner des preuves historiques dans le domaine des fossiles et dans d'autres.

Il faut encore souligner qu'à chaque époque, dans le cadre de conditions nouvelles, les méthodes de recherche doivent s'adapter, au même titre que celles de toutes les activités humaines. Il ne semble pas que la Paléontologie ait suivi cette loi. L'une des caractéristiques actuelles est la nécessité d'un travail en équipe. À la réflexion ce procédé loin d'aliéner la

liberté indispensable au travail de recherche la garantit peut-être plus sûrement que les méthodes actuellement pratiquées.

3.—*Tentatives faites dans le passé* en vue d'une organisation de la documentation paléontologique, voeux émis par divers géologues ou par les réunions internationales, idées se dégageant de divers articles récents.

Ce besoin d'une organisation, d'une mise en ordre, s'est manifesté sous des formes multiples.

Citons les inventaires de faunes, déjà passablement nombreux, publiés dans différents pays, surtout aux États Unis. Les divers tomes du Fossilium Catalogus correspondent à une tendance semblable.

Dans le domaine bibliographique nous pourrions citer des publications semblables connues de tous.

Ces inventaires, ces bibliographies, sont précieux, mais leur consultation est en général laborieuse. La formule du Zoological Records est déjà plus maniable. Celle de Bibliographia Universalis était d'une utilisation pratique.

Des séries de fiches illustrées ont également été publiées, soit sur des groupes particuliers (fichier des Foraminifères), soit sur des faunes déterminées (faunes dévoniennes d'Amérique), soit au sujet des spécimens types ou figurés (Palaeontologia Universalis). Des inventaires de spécimens conférés ont été déterminés par la préparation de certains Congrès. Par exemple pour celui de Moscou plusieurs de ces listes furent mises sur pied en France. De tels inventaires se poursuivent à plus grande échelle actuellement par l'intermédiaire de l'Union internationale de Zoologie sous l'égide de l'UNESCO. En France ils se poursuivent activement et sont communiqués au fur et à mesure au Centre d'Études et de Documentation paléontologiques.

Des conversations avec divers collègues, ou des échanges de lettres avec des géologues français ou étrangers, il résulte que la même nécessité d'un organisme central se fait sentir d'une façon très générale. Un malaise certain existe devant la difficulté de rassembler de la documentation. Je signalerai la publication précédente par le Dr. Haughton, directeur du Service géologique d'Afrique du Sud. Le Dr. Haughton y expose la nécessité d'aboutir à la création d'un organisme central international de renseignements pour les géologues et les paléontologistes (Haughton 1950).

Des organismes généraux ont d'ailleurs été mis sur pied. L'initiative qui nous touche du plus près est le Syndicat de Documentation paléontologique fondé le 10 janvier 1914 par J. Cottreau, J. Groth, P. Jodot, G. Lecointre et P. Lemoine. Malgré les difficultés résultant de la première guerre mondiale, et celles de l'après-guerre, ces géologues réunirent une documentation imposante sur fiches de petit format et sur fiches illustrées (plusieurs centaines de mille de chaque catégorie).

L'organisme le plus représentatif et le plus vivant est l'Union paléontologique internationale dont le président est le professeur Pruvost et l'actif secrétaire le professeur Howell.

Conclusion.—Tout ce qui a été fait dans le domaine des réalisations pratiques est d'une réelle utilité, mais, pour usage, l'ensemble présente le grave inconvénient d'une grande dispersion. Pour, à la fois faciliter le travail technique de détermination, et assurer la progression de la Paléontologie, en facilitant le classement des faits et en provoquant des rapprochements entre observations et idées, il conviendrait de réaliser une centralisation des documents, une organisation plus complète, plus générale, plus méthodique.

II.—PLAN POSSIBLE D'UNE ORGANISATION DE DOCUMENTATION

Sous sa forme complète et idéale une telle organisation comprendrait, un organisme central unique, réunissant tout ce qui correspond aux besoins des Études paléontologiques, et par voie de conséquence à ceux des Sciences de la Terre, et plusieurs organismes régionaux en rapport étroit avec ce Centre.

1.—*Centre international.*—Le principe fondamental doit être le rassemblement et le classement pratique d'un nombre aussi considérable que possible d'informations. Le procédé le plus commode est l'utilisation des systèmes de fiches. Les documents à rassembler seraient:—

(*a*) Des renseignements concernant les collections, les gisements fossilifères, les spécialistes, la terminologie, avec traductions en plusieurs langues, etc.

(*b*) Des indications bibliographiques obtenues par le dépouillement d'un nombre aussi élevé que possible de périodiques et d'ouvrages au fur et à mesure de leur parution. Cette littérature récente devrait être tenue à jour très complètement. Les informations ainsi obtenues seraient mises sur fiches signalétiques bibliographiques et systématiques et sur fiches illustrées. Outre la littérature récente il faudrait envisager de compléter progressivement pour le passé. Les fichiers seraient doublés par des dossiers donnant des analyses plus ou moins étendues des articles importants.

(c) Des traductions intégrales des articles récents et importants. Un facteur très appréciable serait l'obtention très rapide de ces travaux.

(*d*) Des collections de spécimens ou de moulages, de spécimens conférés, de cotypes, ou de tous les exemplaires dont la détermination est garantie par un spécialiste éprouvé.

La diffusion des informations diverses ainsi rassemblées se ferait par correspondance, par communication des documents (on peut par exemple prévoir un prototype demeurant au Centre et un exemplaire circulant), par microfilms, par publication. Le Centre devrait posséder un Bulletin donnant, des traductions, des mises au point, surtout des inventaires et discussions sur les types des collections anciennes. La publication rapide des figurations des spécimens de ces collections historiques est absolument indispensable. Il serait utile de prévoir encore la publication d'une Bibliographie annuelle, comme on le fait dans plusieurs pays, notamment en France par les soins de la Société Géologique. Il suffirait en somme d'élargir l'une de ces publications.

Logiquement ce Centre devrait être le siège de l'Union paléontologique internationale.

2.—*Centres régionaux.*—Pour assurer un inventaire aussi complet que possible, des Centres régionaux seraient en rapport étroit avec le Centre international. Ils pourraient notamment se charger spécialement de l'inventaire de leurs grandes collections nationales. Ils seraient en mesure de fournir des indications sur les périodiques locaux. Les informations relatives aux gisements fossilifères de leurs pays respectifs pourraient être obtenues par leur intermédiaire.

On pourait aussi prévoir une répartition des moyens techniques d'études paléontologiques entre plusieurs de ces centres. En effet une technique particulière n'arrive à donner son plein rendement que si elle est appliquée avec des moyens suffisamment puissants et de façon continue. Il est très difficile qu'un même organisme cultive à fond la pratique de toutes les techniques paléontologiques, d'où l'intérêt d'une répartition.

Enfin ces centres régionaux permettraient d'établir des relations suivies entre le Centre international et leurs spécialistes nationaux.

Je pense qu'il serait possible de prévoir pour l'Europe 4 ou 5 de ces Centres régionaux, par regroupement de pays voisins. Le nombre total serait à discuter. Il semble qu'en règle générale les Services géologiques ou les Sociétés géologiques des différents pays pourraient provisoirement remplir ce rôle ou prendre l'initiative de la création de ces centres.

Conclusion.—La structure idéale ainsi exposée dans ses grandes lignes représente une œuvre de collaboration internationale à grande échelle. L'objection majeure qu'elle soulève est qu'elle peut paraitre utopique par suite de son volume, des dépenses qu'elle représente et du personnel qu'elle demande.

La meilleure réponse à cette objection se trouvera dans l'exposé de la réalisation effective, avec des moyens limités, au Muséum de Paris, d'une organisation qui présente les mêmes caractéristiques essentielles.

III.—LE CENTRE D'ÉTUDES ET DE DOCUMENTATION PALÉONTOLOGIQUES DU MUSÉUM NATIONAL D'HISTOIRE NATURELLE DE PARIS (C.E.D.P.)

1.—*Historique.*—Le C.E.D.P. est sur le plan officiel, la continuation et l'amplification du Syndicat de Documentation paléontologique fondé en 1914, dont il a été question précédemment. L'appel que les fondateurs de ce syndicat lancèrent rencontra la sympathie de l'ensemble de leurs collègues, mais

leur compréhension ne fut que très rarement matériellement agissante. Ils avaient également pressenti les grands organismes scientifiques en vue d'une aide; ceux-ci demeurèrent sourds à cet appel. Cependant, par leurs propres moyens, grâce à l'activité de deux d'entre eux (G. Lecointre et P. Jodot) ils réunirent une documentation importante qui a rendu de grands services à plusieurs paléontologistes.

En 1942, nommé sous-directeur du Laboratoire de Paléontologie du Muséum de Paris, je pensais pouvoir réaliser ce projet d'organisation de la Documentation, auquel je songeais depuis un certain temps déjà. Les circonstances résultant de l'état de guerre me permirent, comme travail préparatoire, de faire un inventaire complet des collections d'Invertébrés du Laboratoire. Dès 1944 ce travail étant terminé, Lecointre m'ayant, en outre, proposé de reprendre le Matériel accumulé par le syndicat de Documentation paléontologique, et diverses autres circonstances intervenant, je commençai la réalisation du Centre d'Études et de Documentation paléontologiques. Le Laboratoire de Paléontologie du Muséum offrait le cadre favorable, le professeur C. Arambourg, directeur de ce Laboratoire, était en outre entièrement acquis à mon idée. C'est en somme un service nouveau qui s'installait, se développait et prenait forme dans ce Laboratoire à partir de 1945, avec l'appui financier du Centre national de la Recherche Scientifique.

La conception que j'en ai correspond au plan idéal du Centre international exposé plus haut. La réalisation, qui va être exposée, le représente dans ses grandes lignes.

2.—*Structure actuelle du C.E.D.P.*—Les collaborateurs du C.E.D.P., en même temps qu'ils poursuivent leurs recherches personnelles, assurent le rassemblement de la documentation, son classement et la constitution de séries de comparaison.

Pour la documentation les sources utilisées sont: les articles contenus dans environ 2.000 périodiques parvenant régulièrement dans les bibliothèques de Paris et les ouvrages qui paraissent actuellement, des fichiers préexistants, des fichiers constitués par les chercheurs du C.E.D.P., ou des spécialistes qui nous en font la communication, des inventaires, répertoires et travaux divers de compilation publiés par des organismes français ou étrangers.

Le C.E.D.P. comprend une section de documentations générale et 17 sections pour la systématique (Micropaléontologie, Coelentérés, Spongiaires, Echinodermes, Vers, Brachiopodes, Mollusques, Crustacés, Trilobites et autres Arthropodes, Paléobiologie, Poissons, Amphibiens et Reptiles, Oiseaux, Mammifères). La section de documentation générale comprend:

(1) des fichiers de renseignements, sur format 125mm. × 75mm. avec les rubriques suivantes:—
termes géologiques (glossaire sur fiches)
termes stratigraphiques
fichier général des genres du règne animal et du règne végétal
fichier des spécialistes et des spécialités
collections
spécimens types et figurés
gisements.
Les catégories 1 et 2 sont, ou seront, doublées par un fichier sur format 125 × 185mm. portant les définitions originales des termes correspondants. Les fichiers 5 et 7 sont, au fur et à mesure des possibilités, doublés par des dossiers détaillés.

(2) Des fichiers bibliographiques également sur format 125 × 75mm.
Les titres majeurs du plan adopté sont les suivants: Minéralogie, Pétrographie, Stratigraphie, Tectonique, Physique du Globe, Phénomènes géologiques, Géologie appliquée, Groupements et activités géologiques, fichier régional, Paléontologie générale et Biologie. Chaque titre est abondamment subdivisé. Par exemple dans la Paléontologie générale on trouvera au chapitre Techniques une subdivision pour l'étude des fossiles aux rayons X. La continuité dans la documentation permettra ainsi de rassembler pour chaque sujet particulier restreint la bibliographie récente, pour ainsi dire automatiquement. Les subdivisions seront de plus en plus nombreuses à mesure que les renseignements s'accumuleront. Les fiches étant tapées en plusieurs exemplaires, quand elles concernent plusieurs rubriques, il

est possible d'être à peu près sûr de ne rien oublier d'essentiel, d'autant plus que des renvois sont indiqués pour les rubriques qui peuvent chevaucher. Classé suivant le même plan se trouve déjà un nombre assez considérable de dossiers avec analyses d'articles.

Les différentes sections de la Systématique sont toutes construites suivant le même schéma. Elles comprennent un fichier bibliographique général, avec un classement méthodique, un fichier général des espèces de la classe correspondante, dans l'ordre alphabétique, un fichier général des genres et toutes les catégories d'ordre générique ou supérieur, avec indication sur chacune de la catégorie supérieure dans laquelle elle est classée pour le C.E.D.P. Ce procédé, préconisé par les fondateurs du S.D.P., est le seul qui permettra de retrouver, certainement groupées, les indications relatives à un groupe. Les fiches de genres sont évidemment dans l'ordre alphabétique. Un fichier des exemplaires types et figurés du groupe correspondant est également prévu.

Pour chaque classe la classification a été établie jusqu'à la sous-famille, le cadre ainsi tracé doit demeurer stable et toute catégorie nouvelle doit y trouver sa place, soit qu'elle soit acceptée, soit qu'elle soit admise en synonymie avec une autre. Cette classification sert à l'établissement du fichier systématique. Exactement parallèle existe un fichier illustré sur format 185 × 250mm. Le principe adopté dans l'établissement de ces fiches illustrées est l'impartialité totale. Elles reproduisent exactement la figuration de l'auteur, la description et les indications qu'il donne, quitte à donner en remarque les corrections indiscutables nécessaires. Ces fiches illustrées intéressent les différentes catégories taxonomiques. Pour les genres et catégories supérieures elles comportent en outre l'indication des différents représentants des catégories inférieures qu'elles renferment et la répartition stratigraphique et géographique. Pour les espèces actuelles, ou les groupes vivants en général, la distribution bionomique est aussi prévue.

Dans l'établissement de ces fichiers des différentes classes de la systématique il est d'ailleurs nécessaire de faire preuve d'une certaine souplesse suivant les groupes, suivant l'état d'avancement des recherches paléontologiques, suivant l'abondance des représentants.

A chaque groupe de la classification se trouvent d'ailleurs adjointe la bibliographie correspondante. En outre des dossiers donnent, comme pour les fichiers bibliographiques, des analyses d'articles.

Les collections de comparaison, dont la réalisation est plus ou moins avancée suivant les groupes, ont été constituées par les collections existant au Laboratoire de Paléontologie, par les moulages d'échantillons communiqués par d'autres Musées. Il est prévu d'y incorporer des cotypes, que les auteurs d'espèces nouvelles nous ont promis. Ce procédé serait à généraliser dans la mesure du possible.

3.—*Conditions matérielles.*—Il est utile d'entrer dans quelques détails sur les conditions matérielles dans lesquelles cette expérience de Centre de Documentation s'est déroulée. Ce sont eux, en effet, qui donneront une idée des possibilités d'extension.

Les locaux dont dispose le C.E.D.P. sont suffisamment vastes, mais leur aménagement est incomplet. Il en est de même pour leur ameublement. Le personnel scientifique est représenté par 4 personnes seulement, qui, j'y insiste, n'abandonnent pas leurs recherches personnelles.

Le personnel technique n'a d'abord compris que 2 dactylographes, puis 3 et un aide-technique.

Les crédits pour fonctionnement, achat de matériel (classeurs, fiches, etc.) se sont élevés pour l'année 1947 à environ 300.000 francs.

Il semble donc, qu'aussi bien en ce qui concerne le personnel qu'en ce qui concerne les crédits, le C.E.D.P. ne représente pas une charge très considérable. Sa continuation et son extension éventuelle seraient donc dans le domaine des possibilités.

Conclusion.—Je voudrais terminer cet exposé par un appel et une proposition. Il semble que l'accord se trouve réalisé entre les chercheurs des Sciences de la Terre pour reconnaitre la nécessité impérieuse et urgente d'une organisation facilitant les travaux. Sa réalisation n'est qu'une question de

collaboration. Que les particularismes exagérés s'atténuent devant l'intérêt supérieur du progrès scientifique, que les questions d'amour propre excessif disparaissent, et, tous ensemble, nous pourrons arriver à canaliser les données multiples qui nous sont nécessaires, nous pourrons les classer et aider ainsi mutuellement les recherches et préparer un terrain favorable pour nos successeurs.

Je proposerai donc que l'Union paléontologique internationale ait un siège effectif, rejoignant ainsi le projet soumis par le Dr. Haughton. Je solliciterai, en outre, pour la France, pour le Centre d'Études et de Documentation paléontologiques, l'honneur d'être ce siège.

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DISCUSSION

A. DESIO (Italy) disse che la Rivista Italiana di Paleontologia e Stratigrafia, la quale ha più di mezzo secolo di vita è divenuta organo ufficiale della Società Paleontologica Italiana la quale fù fondata a Milano nel mese di dicembre 1947.

Annunziò che la " Collezione Brocchi " ch'era conservata nel Museo di Storia Naturale di Milano è salva, malgrado il Museo sia stato in buona parte distrutto durante la guerra.

M. P. WHITE (U.S.A.) called attention to the recent launching of a new quarterly publication *The Micropaleontologist* containing information about current events in the field of micropalaeontology. The journal is obtainable at a cost of one dollar per year from the American Museum of Natural History in New York.

C. J. STUBBLEFIELD (Great Britain) remarked that if members wished to see copies of any publication mentioned in the first three publications, these were available in the nearby libraries of the British Museum (Natural History), or of the Geological Survey and Museum.

E. I. WHITE (Great Britain) referring to the papers by Dr. Haughton and Dr. Roger, considered that the scheme outlined, while desirable, was impracticable because of its cost and because of the additional burden it would place on the shoulders of overworked specialists. In his opinion it would be better for palaeontologists to support such publications as the *Zoological Record* which dealt fully with all palaeozoological literature, and had been continuously published for many years.

A. MORLEY DAVIES (Great Britain) said that he had been shown the methods of the Syndicat de Documentation Paléontologique twenty-five years ago, and he was glad to know of the extension of the system described by Dr. Roger.

V. VAN STRAELEN (Belgium) pointed out the difficulties inherent for workers in small countries where libraries were small and few.

E. I. WHITE (Great Britain) replied that he could not agree that any form of abstracting could have the same authority as original papers, and that in his opinion no abstracts could take the place of original literature, which he claimed was fully documented in the *Zoological Record.*

G. F. ELLIOT (Great Britain) stated that it would be necessary to give careful consideration to the financial problems involved in Dr. Roger's plan. He feared that the three or four scientific workers and the three typists suggested would prove inadequate for the proper working of the plan and that it might be difficult to secure the funds which would eventually be needed.

H. G. RAGGATT (Australia) said that he considered that such an organization as Dr. Roger had proposed was so greatly needed that the possibility of securing the funds should be explored, even if a large sum were required.

J. ROGER dit, " Les dépenses entraînés par un centre de documentation ne peuvent pas croître dans de grandes proportions au cours de son développement car les dépenses au cours des deux dernières années ne se sont pas accrues malgré l'augmentation des prix."

D. A. BROWN (New Zealand) pointed out that the needs of workers in regions where the older literature was not available could now be met in part by the use of microfilm copies of the papers desired.

P. C. S. BRADLEY (Great Britain) drew attention to the American journal, *Biological Abstracts*, which contains abstracts of most of the palaeontological papers published, and urged that palaeontologists give this journal their support.

G. F. ELLIOTT, in reply to a question by Dr. Shirley concerning the practice of the oil companies' palaeontologists, who often use numbers, rather than scientific names, to designate the different kinds of fossils with which they have to deal, said that this procedure was useful for local work, but that for the correlation of faunas found in widely separated areas it was necessary to employ appropriate scientific names for the different species.

2. THE USES OF FORAMINIFERA IN STRATIGRAPHICAL PALAEONTOLOGY

The second open meeting of the Union was held on August 30th with Vice-President A. Morley Davies (Great Britain) in the chair. The symposium was organized by C. D. Ovey (Great Britain) and ten papers were communicated in the order printed below. Discussions took place at three stages of the meeting; the first after the reading of the paper by R. Grill, which paper had concluded that aspect of the symposium dealing with the Mesozoic Palaeontology of Europe. The next period of discussion was concerning particular aspects of the palaeontology of the Indo-Pacific region; this followed the reading of the paper by L. M. Davies.

The meeting concluded after a short discussion of the paper by J. Cuvillier.

THE USES OF FORAMINIFERA IN LOWER JURASSIC STRATIGRAPHY

By T. BARNARD

Great Britain

ABSTRACT

Foraminifera are found at most Lias horizons in England, and are very abundant at some levels. Until recently they have been neglected as an aid to Jurassic stratigraphy, probably in view of the abundant microfauna. The macrofauna, particularly the ammonites, is not found in all localities, thus providing a reason why a study of the foraminifera is important.

A range table for some foraminifera is given. Broad faunal divisions are suggested, together with a more detailed zonal sequence of parts of the succession, and an account of some important marker horizons. The broader palaeontological and ecological problems involved, concerning the wide distribution of some species over W. Europe, together with the faunas associated with the local conditions in areas of movement, are discussed. The difficulty experienced in detailed zoning is commented on and an account of the migration of faunas is given.

UNTIL the recent work of Franke (1936), Bartenstein and Brand (1937), and Macfadyen (1941) the study of Lower Jurassic microfauna had been seriously neglected for a long time. These later works are based on systematic stratigraphical collecting, enabling ranges of species to be accurately delimited; and also the tangled synonymy is being straightened.

The following paper is based on collections from many Lias localities, and gives the broad facts, most of which are as yet unpublished. Ammonites are often fragmentary or absent and it is here that foraminifera prove useful in indicating the stratigraphical position of the deposits. Nomenclatorial problems are outside the scope of this study, but well established names will have to be replaced later by the less familiar on grounds of priority.

FAUNAL DIVISIONS OF THE BRITISH LIAS, AND A COMPARISON WITH THOSE OF EXTRA-BRITISH AREAS

One species, *Lingulina tenera* Bornemann, ranges through the whole Lias to the Middle Jurassic; another, *Marginulina prima* d'Orbigny ranges through the Lower and Middle Lias. On the whole,

these forms show very little change. At certain horizons, however, abundant stunted or malformed specimens do occur and an attempt has been made, with no success, to correlate these horizons, to see whether the particular environmental conditions responsible for these faunas was widespread. This was rendered almost impossible by the occurrence of so many secondary and localized limestones which made the tracing of individual beds impossible. It is believed, however, that these faunas of malformed and of normal, robust specimens are of local occurrence only and each is due respectively, to an unsuitable or suitable ecological niche.

Differences in local conditions, together with inherent tendencies within the organisms themselves, produce individual variation, extremes of which have accounted for a detailed subdivision of these species by some authors. Although many of these " species " were recognizable they were found to be of little or no stratigraphical importance.

Both in England and in Germany the *planorbis* zone has no distinguishing form. Records show that only doubtful smooth *Dentalinae* e.g., *Nodosaria nitidana* Franke (=*germanica* Franke), *N. metensis*, Terquem (=*fontinensis* Terquem), occur together with malformed specimens of *Marginulina prima* d'Orbigny. The specimens are rare, and usually badly preserved. The thin black shales together with numerous secondary limestone partings render collecting of good material difficult.*

The base of the *angulatum* zone marks a sudden increase both in the number of individuals and of species, and throughout the Sinemurian (Lias α and β) foraminifera remain abundant in England.

It is possible to divide broadly this part of the Lower Lias into several well-marked divisions, subdividing into many smaller divisions. Two forms, *Planularia* [*Cristellaria*] *inaequistriata* Terquem and *Frondicularia brizaeformis* Bornemann (=*major* Born.), occur together and range through the *angulatum*, *bucklandi* and the lower half of the *semicostatum* zones.

Occurring rarely in the Upper Lias there is another *Frondicularia* somewhat similar to *F. brizaeformis* Born., so it is advisable to name the zone *inaequistriata* after the *Planularia*.

Occurring in the Middle and Upper Lias, and more plentifully in the Inferior Oolite (*Ludwigia* zone) is *Planularia* [*Cristellaria*] *eugenii* Terquem (=*arietis* Issler). This form appears to be similar to *P. inaequistriata* Terq. but a detailed study soon shows the differences. The *inaequistriata* zone almost coincides with that given by Bartenstein and Brand (1937).

One form, *Dentalina matutina* d'Orbigny, characterizes the upper part of the *semicostatum* zone up to that of *raricostatum*.

There is a slight overlap between this, the *matutina* zone, and the preceding *inaequistriata* zone, in the middle of the *semicostatum* ammonite zone. The *matutina* zone coincides almost exactly with Bartenstein and Brand's (1937) *Nodosaria issleri* stage. *N. issleri* has not yet been found in the British Lias so it is advisable to name the zone after an abundant, easily identifiable form, the range of which is nearly identical with that given for the German Lias.

The Lower Pliensbachian (*jamesoni-ibex* zones) in the exposures of S.W. England show little change of fauna. Foraminifera are rare, and the long-ranged forms make subdivision unreliable and almost impossible.

Frondicularia bicostata d'Orb. is unlike the other zonal forms, which appear quite suddenly. This species characterizes the upper part of the *raricostatum* zone, up to the *spinatus* zone in the Middle Lias. This form evolves as a variant of *Frondicularia dubia* Born. in which two central longitudinal costae are accentuated at the expense of others. For a long time this form occurs with *F. dubia* and a number of intermediates. Presumably natural selection sifts the forms and gradually *F. bicostata* d'Orb. gains supremacy at the expense of its " parent " *F. dubia*, only to be succeeded by *F. terquemi* d'Orb., a smooth form derived from *F. dubia* by the gradual loss of ribs.

The range of *F. terquemi* d'Orb. corresponds almost exactly with that of *Bolivina rhumbleri* Franke which occurs in the German Lias, but is very rare in most of the British Pliensbachian horizons, and is therefore unsuitable for choice as a zonal form.

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*For distribution of species, see range table (p. 36, fig. 1).

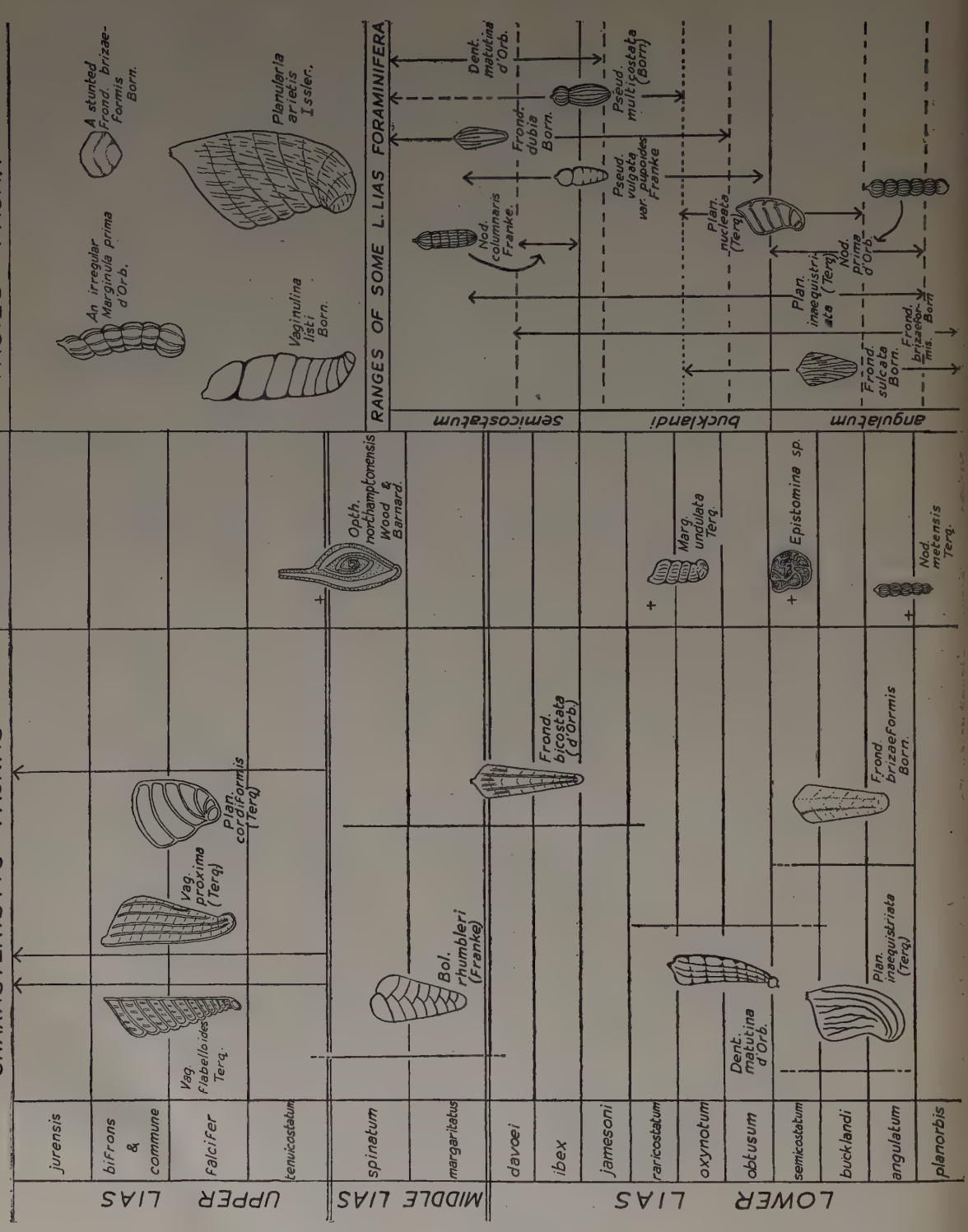

FIG. 1.—*Lias Foraminifera.*

On the whole, the foraminiferal fauna of the Middle Lias (*margaritatus* and *spinatum* zones) is a continuation of the *davoei* faunas.

The Middle Lias foraminifera almost entirely disappear at the junction with the Upper Lias, and a new fauna with very distinctive elements appears, bearing stronger relationships to that occurring later in the Upper Jurassic and Lower Cretaceous.

The principal forms range through the Upper Lias into the Oolites. There are many variations of these species but here they are included as two species groups. Firstly, *Citharina* [*Vaginulina*] *flabelloides* (Terquem), a very distinctive ribbed *Citharina*, marks the advent of the ribbed *Citharinae* which continue throughout the Upper Jurassic and Cretaceous, and are usually an important part of the faunas of various subsequent horizons. Secondly, *Vaginulina proxima* (Terquem), the first species of the coarsely longitudinally costate *Vaginulinae*, is chosen as the central species of a whole group of coarsely ribbed forms, with numerous slight variations, but all conforming to the general description. Bartenstein and Brand (1937) erected several species centred around *V. harpa* Roemer and *V. proxima* (Terq.). Accompanying these two forms is *Planularia cordiformis* (Terquem), a vitreous, smooth, unornamented foraminifer occurring abundantly at the junction of the Middle and Upper Lias and remaining abundant throughout the Upper Lias and Lower Oolites. In this material there are many of the Upper Lias forms described by Terquem (1858–66) and redescribed by him (often under new names) in a later work (1868–79).

Bartenstein and Brand (1937) divide the Middle and Upper Lias on the occurrence of " *Cristellariae*," the former being characterized by *Cristellaria acutiangulata* (Terquem) and *C.* (*Saracenaria*) *sublaevis* Franke and the latter by *C. d'orbignyi* (Roemer). In the author's experience these " *Cristellariae* " are a most variable and difficult group to identify accurately, especially as they show very well the principle of recurrence of morphological types, and like forms may appear at widely differing horizons. Until more is known about the complicated group, especially during their acme in Jurassic times, it is safer not to base conclusions on these foraminifera.

MORE DETAILED DIVISIONS OF PART OF THE LOWER LIAS

A detailed study of the whole Lias is beyond the scope of this paper, but that it can be done is demonstrated by a minute study of the foraminifera in the ammonite zones of *angulatum*, *bucklandi* and *semicostatum*.

Foraminifera are abundant at most horizons and in the area of grey mud deposition shows little or no variation. It is therefore proposed to base the divisions on the foraminifera collected from one of these regions, namely the Dorset Coast, as here the sedimentation was much more continuous than where the axes of uplift occur crossing or dividing basins of deposition.

The table on page 38 (Fig. 2) shows the approximate ranges of some of the forms. It is not possible to mention all the species for some are new and will be described in a later work.

From the above table it can be seen that by the study of the foraminiferal assemblage a division into broad zones is possible. The *angulatum* zone can be divided into three subdivisions. The lower third of the zone contains the two forms *Frondicularia sulcata* Bornemann together with *F. brizaeformis* Born. (=*major*). The middle third contains the same but with foraminifera *Planularia* [*Cristellaria*] *inaequistriata* (Terq.) and *Nodosaria prima* d'Orb. in addition. The former occurs abundantly from this level to the middle of the *semicostatum* zone and is taken as the zonal species. The latter is of more restricted range disappearing at the top of the *angulatum* zone. The upper third of the zone is characterized by all the above forms with the addition of *Planularia nucleata* (Terquem).

The *bucklandi* zone may be divided into two main divisions, each one again divisible into two subdivisions. Whereas the *angulatum* zone was characterized throughout by the appearance of new members to the assemblage the *bucklandi* zone marks the disappearance of some species together with the occurrence of new elements. The two parts are almost equal, bounded by the disappearance of *Frondicularia sulcata* Born. and *Planularia nucleata* (Terq.) and incoming of *Pseudoglandulina multicostata* Bornemann. *Nodosaria prima* d'Orb. disappears at the junction of the *angulatum*-

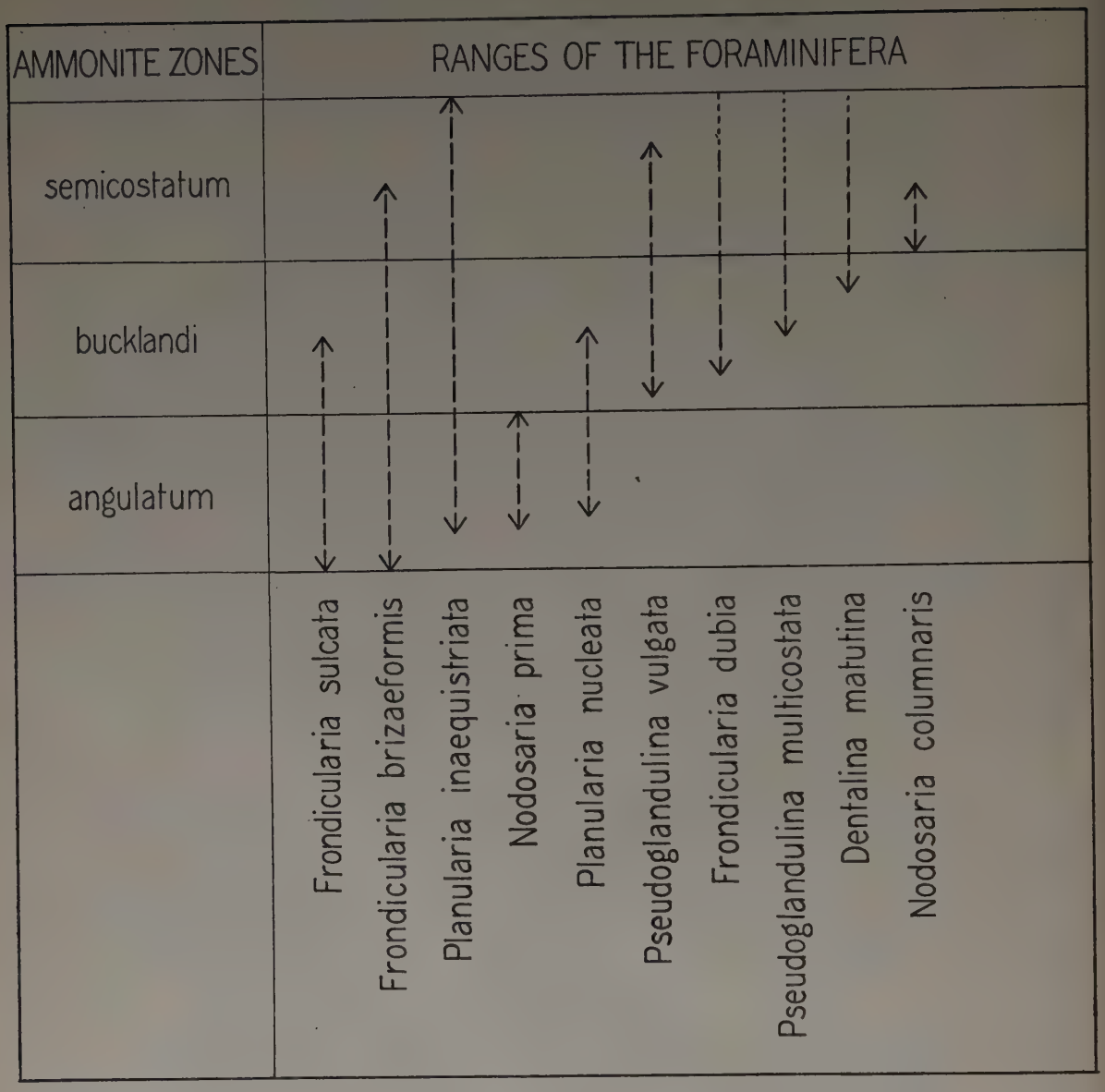

FIG. 2.—*Approximate ranges of some Lower Lias Foraminifera.*

bucklandi zones, so that the assemblage now consists of *Frondicularia sulcata*, *F. brizaeformis*, *Planularia inaequistriata* and *P. nucleata*. The lower division, as stated above, falls into two subdivisions, the lower characterized by the addition of *Pseudoglandulina vulgata* var. *pupoides* Franke and the upper half by the presence of the coarsely costate *Frondicularia dubia* Bornemann. The upper division is marked by the following assemblage: *Frondicularia brizaeformis*, *Planularia inaequistriata*, *Pseudoglandulina vulgata* var. *pupoides*, *Frondicularia dubia*, together with the following new forms *Pseudoglandulina multicostata* (Born.), characteristic of the lower subdivision, and the further addition of *Dentalina matutina* d'Orb. occurring in the upper part.

The junction of the *bucklandi-semicostatum* zones is marked by the appearance of *Nodosaria columnaris* Franke. Some difficulty was experienced in making divisions within the *semicostatum*

zone, but a two-fold separation is possible, marked by the disappearance of *F. brizaeformis* and of the short ranged *N. columnaris*. The two assemblages are as follows: the lower, *F. brizaeformis*, *P. inaequistriata*, *Pseudoglandulina vulgata* var. *pupoides*, *F. dubia*, *Pseudoglandulina multicostata*, *D. matutina*, *N. columnaris*; and the upper, *P. inaequistriata*, *P. vulgata* var. *pupoides*, *F. dubia*, *D. matutina*; *P. vulgata* var. *pupoides* and *F. dubia* become rare and sporadic towards the top of the zone.

SOME IMPORTANT MARKER HORIZONS

It is desirable to define more accurately the term horizon, as used here. Usually, horizon is taken to mean an imaginary plane with no three-dimensional limits, but here it is taken to indicate a layer with species of a very restricted range. The term subzone is hardly applicable for here the limits of a so-called subzone are much larger. A few of the more important marker foraminifera are chosen as examples.

At the base of the *angulatum* zone, and occurring in one bed only is *Nodosaria metensis* Terquem. This form appears at about the junction of the *planorbis-angulatum* zones in Germany. *Epistominae* occur at several restricted levels, one of these is at about the middle of the *semicostatum* zone. *Epistomina* cf. *mosquensis* Uhlig is found abundantly at this horizon. *Marginulina undulata* Terq., an easily distinguishable form, marks an horizon at about the middle of the *raricostatum* zone, occurring abundantly. Several members of the family Ophthalmidiidae are important as markers at different levels. *Ophthalmidium macfadyeni* Wood and Barnard has a range through the *davoei* zone. The occurrence of this species is not regular and is restricted to a few bands, with apparently little difference in the variation seen at the different levels.

Ophthalmidiidae mark the base of the Upper Lias, occurring so abundantly as to make a well-marked band extending over a considerable area. The species include *Ophthalmidium northamptonensis* Wood and Barnard, *O. nubeculariformis* Haeusler and *O. walfordi* Haeusler which were dealt with in an earlier paper (Wood and Barnard 1946). This bed at the base of the Upper Lias is characterized by other markers such as *Epistomina* sp. and *Calcitornella* sp. which are confined to about six feet above the junction of the Middle and Upper Lias.

FACIES FAUNAS AND FAUNAS OF WIDE AREAL EXTENT

For the most part the foraminifera of the Lower Jurassic belong to one family, the Lagenidae. At this period in their history many divergent stocks were arising, producing many new forms showing extreme variation. Before Jurassic times the Lagenidae were very restricted both in the number of species and occurrence; then, during the Jurassic, they reached their acme of development, and from then on their history is one of convergence towards specialized types as opposed to the rapid divergence into numerous stocks so typical of Jurassic forms. The classification of this family is based for the most part on a study of Tertiary and Recent species. A study of literature regarding the ecology of the Lagenidae shows that recent species are extremely restricted and specialized.

From a study of important ecological work by Norton (1930) and Natland (1933) it is clear that members of the Lagenidae vary considerably in their bathymetric range. Often common in zones between 5-60 fathoms the Lagenidae persist to great depths, but usually here the numbers are small (Glaessner, 1945). Norton (1930) concludes that members of the Ophthalmidiidae are not confined to definite temperatures or depth conditions, but certain genera favour warm shallow zones.

Arenaceous genera, except *Ammodiscus*, *Tolypammina* and *Ammovertella*, are very rare in the Lias. These forms were found by Norton to occur most commonly in the deeper cooler oceanic waters. The occurrence of these forms associated with shallow water conditions in the Lias seems to be in direct opposition to the above. *Ammodiscus* occurs in " nests," usually associated with an abundance of other forms, and seems to be indicative of shallow water. *Tolypammina* and *Ammovertella*, adherent foraminifera, are in greatest abundance where organic debris is common. The beds at the base of the Blue Lias (pre-*planorbis*, *planorbis*, *angulatum*), crowded with fragmentary *Ostraea* spp. and " *Gryphaea* " spp., have abundant species. Both *Ostraea* and *Gryphaea* are associated with shallow water.

Later, in Upper Lias times, these foraminiferal genera are again important particularly in beds containing *Isocrinus* spp., again possibly a warm shallow water genus. Associated with both of these deposits are numerous fragmentary remains of the Cidaroidea usually indicative of intertidal zones.

Norton states that " members of the Textularidae are rather common in the shallow warm water areas." So far the only two species of *Textularia* found occur around the Mendip Archipelago in the *turneri* clay, and in the *davoei* zone of Lincolnshire where Trueman recorded *Textularia* sp. as being abundant. Both species are associated with sediments indicative of shallow water.

Returning to the family Lagenidae, Cushman states that the greatest development of the family seems to be in tropical regions at depths of 100-500 fathoms. Most authors seem to be in agreement therefore that at the present time members of the Lagenidae are confined to deeper water.

One or two points regarding the occurrence of the genera are worthy of notice.

Norton (1930) states that *Lenticulina* and its allied genus *Robulus* are rarely met with in shallow tropical regions. Cushman states that this genus reaches a great development in tropical waters (100-500 fathoms). Recent species of *Lenticulina* seem to show a tendency towards specialization in habitat but earlier forms, both Jurassic and Cretaceous, occur in a wide range of deposits indicative of many different ecological conditions. Near-shore Liassic deposits, particularly around the Mendip islands, have a great abundance of this and many associated genera.

Further, regarding *Nodosaria*, Norton states that both *Nodosaria* and *Dentalina* are rare at depths less than 60 fathoms, again pointing to specialization in habitat amongst late forms.

It is not logical to base generalizations on the evidence obtained from a very few Recent species, but I think it can be definitely stated that during the early part of the history of this family, the ecological range was much greater than that at present. It seems from all the existing evidence, lithological as well as palaeontological, that the Lagenidae occurred in much shallower water than at the present day. This leads me to believe that the bluish-grey clays of parts of the Lias succession were not as stated in most text-books and many papers as being deep-water deposits, but are probably shallow water sediments associated with mud-flats.

In spite of many local changes in environment some forms persist over wide areas. This is to be expected among the later planktonic forms where distribution is governed largely by ocean currents and surface winds; but where benthic foraminifera are concerned, numerous other factors govern their distribution, it is therefore surprising that the areal extent is so great.

The bathymetric range of some species must be broad, for they occur in many different sediments, indicating a wide range of tolerance to differing environment, and the usefulness of such forms cannot be underestimated for purposes of correlation.

Several examples may be given extending over most of the Lias outcrops of N.W. Europe. *Planularia* [*Crist.*] *inaequistriata* (Terquem), *Dentalina matutina* d'Orb., *Citharina* [*Vaginulina*] *flabelloides* (Terquem) and *Planularia* [*Cristellaria*] *cordiformis* (Terq.), have been recorded from various localities in Britain, France and Germany. These species are useful as zonal indicators. Other species of widespread occurrence but of little stratigraphical use, are *Marginulina prima* d'Orb. and *Lingulina tenera* Bornemann.

The Jurassic with its numerous basins of sedimentation and regions of uplift is especially suitable for the study of the effects of different environments on the foraminiferal faunas. One of the chief differences between the fauna of the centres of the " basins " of deposition (Dorset Coast, Cheltenham) and those occurring near areas of uplift, is well shown in a comparison between the *turneri* zone of Dorset and Radstock. At Radstock to the North of the Mendip axis the *turneri* zone is represented by less than 5ft. of sandy blue clay, on the Dorset Coast by about 15ft. of greyish blue calcareous mudstone and shales. The foraminifera are rare in this zone from the Dorset Coast, and consist of only very few stable species, showing little or no variation. Here the forms present are the long-range species such as *Marginulina prima*, *Lingulina tenera* together with several species of *Lenticulina* and occasionally, at a few horizons, but only occurring abundantly in bursts, *Spirillina infima* (Strickland).

Contrasted with this, the sandy clays of Radstock contain a very abundant and varied fauna. *Lingulina tenera* shows a wider range of variation in both size and degree of ornament than on the Dorset Coast. *Spirillina infima* and *Tolypammina* sp. occur with little difference. *Marginulina prima* and some species of *Nodosaria* (both ribbed and smooth) show an outstanding difference in variation, the megalospheres are much larger (twice the diameter) and very irregular in shape compared with the same species at Lyme Regis and Cheltenham. After the initial proloculum the remainder of the test is extremely irregular, so irregular in fact that it is difficult with isolated specimens to assign them to their correct species. This irregularity is obviously directly connected with the difference in environment. Most species occur much more abundantly here than on the Dorset Coast area.

Species occur around the Mendip islands which are not found in the centres of the " basins " of sedimentation. The larger *Planularia* cf. *arietis* (Issler) occurs abundantly, *Vaginulina listi* Born. shows many variants almost passing into a *Dentalina*. *Textularia* sp. nov., together with a very minute *Trochammina* sp. nov. are the chief arenaceous species. *Frondicularia dubia* Born. shows great variability in size.

Associated with the sandy clays of Radstock and those of Byfield (Upper Lias) are numerous well-formed, robust specimens of *Lenticulina münsteri* (Roemer). This species seems to thrive under the conditions associated with this type of deposit.

There are many other normal and abnormal individuals of a large number of species obviously belonging to this facies fauna, a shallow water facies. The attenuated succession at Radstock may differ from the thicker deposits elsewhere, in that the lack of sediment may have resulted in a segregation of several generations of foraminifera. However a comparison with the lack of variation as shown by the fauna from the Dorset Coast sediments suggests that this is not the case.

CONCLUSIONS

It is possible after an elimination of facies-fauna species to divide the Lias into broad divisions, and, as a result of more detailed work, into finer zones. The areal extent of all the zonal foraminifera has not yet been tested, but in many instances they are valid. If the variability of certain species is studied then the variants can be grouped and the distribution determined.

Regarding the taxonomy of the species, it can be stated that many of the difficulties will only be eliminated after a complete study of Terquem's types.

It can therefore be concluded that in many problems of Lower Jurassic stratigraphy, foraminifera will prove invaluable.

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RÉPARTITION STRATIGRAPHIQUE DE QUELQUES GRANDS FORAMINIFÈRES DANS LE FLYSCHE CRÉTACÉ SUPÉRIEUR NORD PYRÉNÉEN (S.W. FRANCE)

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ABSTRACT

Au début, et pendant le Crétacé supérieur, la mer déborde au S. et au N. le domaine géosynclinal ou s'accumulent des dépôts orogènes. Elle dépose au S., sur les futures Pyrénées, et au N.—N.E., sur le glacis qui remonte vers le Massif Central, Montagne Noire, Mouthoumet, des calcaires épicontinentaux datés par des macrofossiles qui ont permis d'établir une stratigraphie. Dans le domaine du flysch, l'absence de macrofaune rend l'établissement de celle-ci délicate, il a fallu faire appel aux microfossiles, surtout aux grands foraminifères, et raisonner par analogies avec les microfaunes connues. datées, des séries épicontinentales, en tenant compte des migrations possibles.

Les principales familles dont les associations sont significatives sont: les Alveolinidae, Orbitoididae, Miliolidae trematophorés, Calcarinidae, Valvulinidae. Elles existent dans des calcaires lenticulaires à algues du flysch, fréquemment dans des microbrèches calcaires ce qui peut faire présumer alors d'un remaniement possible; il n'en reste pas moins que l'ordre d'apparition de certains genres, constitue, sur le plan régional, un excellent critère stratigraphique.

Parmi les Alveolinidae, *Prealveolina* apparait au Gargasien, atteint son épanouissement au Cénomanien en même temps que *Ovalveolina*; ces deux genres paraissent se prolonger au Sénonien. *Subalveolina* débute au Santonien dans le domaine flysch, et émigre plus tradivement sur la plateforme épicontinentale.

Les Orbitoidae apparaissent au Santonien avec *Monolepidorbis* que se divise au Campanien en deux troncs aboutissant: l'un à *Orbitella*, l'autre au genre *Omphalocyclus*, très developpé au Maestrichtien. *Lepidorbitoides* et *Clypeorbis* sont limités à cet étage.

Parmi les Miliolidae trématophorés, *Lacazina* parait au Santonien.

Les Valvulinidae répresentés par *Dicyclina* ne sont connus dans le flysch qu'au Senonien inférieur.

Les Calcarinidae enfin sont répresentés pour la première fois au Santonien par un *Siderolites* inerme, ils ont leur développement maximum au Maestrichtien avec *Siderolites calcitrapoides*.

FORAMINIFEREN ALS LEITFOSSILIEN IN DER OBERKREIDE INSBESONDERE NORDWEST-DEUTSCHLANDS

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ABSTRACT

Für die Feinstratigraphie der nordwestdeutschen Oberkreide kommt den Kleinforaminiferen eine grosse Bedeutung zu. Zwei Wege haben zum Teil unabhängig voneinander zu denselben Ergebnissen geführt, der routinemässige Faunenvergleich durch die angewandte Mikropaläontologie und dann das Auffinden von horizontbeständigen Leitfossilien von kurzer Lebensdauer. Ebenso wie sich beide Methoden mit Grossfossilien seit langem bewährt haben, konnten sie auch in der Mikrostratigraphie mit Erfolg verwendet werden Die diesbezügliche Bedeutung von Oberkreideforaminiferen wird an Hand von einigen Beispielen erläutert. Die Formenreihen von *Bolivinoides austinana—decorata—draco—rhomboidea* und von *Flabellina pachydisca—deltoidea—interpunctata—sphenoidalis—efferata—leptodisca—reticulata* werden besonders hervorgehoben. Die Entwicklung vieler dieser Typen ist nicht gradlinig hintereinander erfolgt. Sie muss wesentlich verwickelter gewesen sein. Hierbei halten besonders bei den Flabellinen einige Primitivtypen länger an, bzw. müssen mehrfach neugebildet sein. Die nomenklatorische Behandlung solcher Mutationsreihen erweist sich als sehr schwierig: Zu weit gefasste Artbegriffe müssen zerlegt werden und gleiches, was unter verschiedenen Artnamen beschrieben ist, muss vereinigt werden. Das Vorhandensein ähnlicher Reihen konnte in verschiedenen Faziesgebieten Europas festgestellt werden. Bis jetzt spricht nichts dagegen, dass die gleichen Foraminiferentypen auch an allen Fundpunkten zur gleichen Zeit aufgetreten sind. Höchstwahrscheinlich haben viele auch ihre Gültigkeit als Zeitmarken für eine weltweite Stratigraphie der Oberkreide.

DIE Erdölbohrtätigkeit stellte die nordwestdeutschen Geologen vor die Aufgabe, die mächtige Folge der Sedimente unserer Oberkreide den Ansprüchen der Praxis gemäss zu unterteilen. Das heisst in der Erdölgeologie bekanntlich nicht, grosse stratigraphische Einheiten oder theoretische Zonen zu haben, sondern es muss in möglichst vielen Fällen eine einwandfreie konkrete Feinhorizontierung gegeben werden können. Nur so ist es möglich, die Fragen der technischen Geologie und der Tektonik mit der genügenden Sicherheit und Präzision zu beantworten. In vielen anderen Formationen ist die Schaffung einer Feinstratigraphie begünstigt durch vertikale Fazieschwankungen, die mit Hilfe von Petrographie und Grossfossilien relativ leicht zu fassen sind. In unserer Oberkreide, vor allem im Campan, Santon und Coniac, versagen aber diese bewährten Methoden. Megafossilien sind zu selten, und vertikale Faziesschwankungen zeichnen sich angesichts der gleichbleibenden rein marinen Fazies petrographisch zu ungenügend ab. Nachdem für die Unterkreide eine ausreichende, auch durch Mikrofossilien fundierte Feinstratigraphie aufgestellt war, war es für die Mikropaläontologie Nordwest-Deutschlands eine der dringendsten Aufgaben, die Gliederung der Oberkreide in Angriff zu nehmen.

Während die Foraminiferenarbeiten von Franke (1928) noch rein systematisch ausgerichtet waren, konnten in unserer Oberkreide Thalmann und R. E. Koch (1931–35) und dann Hecht auch mit Hilfe von Foraminiferen drei Stufen unterscheiden. Nach der einzigen hierüber bestehenden kurzen Veröffentlichung von Hecht (1937) wurden damals unter Benutzung der bei der Shell üblichen Ziffernnomenklatur das Mucronaten-Senon bis Quadraten-Senon, dann das Granulaten-Senon bis Turon und das Cenoman jeweils als eine Stufe zusammengefasst. Obwohl es sich hierbei noch um eine erste behelfsmässige und unbefriedigende Grobgliederung handelte, konnte Hecht hiermit schon eine Vorstellung gewinnen (1937, S.217, Abb. 3) von dem Ablauf tektonischer Bewegungsvorgänge in der Oberkreide an einem Salzstock.

Völlig unabhängig davon konnte Wicher 1934–35 schon wesentlich genauer unterteilen, und zwar auf Grund des Auftretens und Verschwindens von *Stensiöina exsculpta*, verschiedenen Formen

von *Bolivina incrassata*, *Bolivinoides*-Arten, verschiedenen Flabellinen, Globotruncanen und Gümbelinen. Seine Gliederung wurde von den Mikropaläontologen der Erdölindustrie übernommen und in kritischer Zusammenarbeit ausgebaut. Die Kontrolle mit den von den Erdölgeologen im Laufe der Jahre zusammengebrachten Grossfossilien ermöglichte eine Abstimmung der Wicher-'schen Foraminiferen-Stratigraphie. Schon bald hatte Wicher erkannt, dass seine Faunengliederung allein nicht ausreichte. Seine mehrjährigen Untersuchungen zeigten, dass sich im Mucronaten-Senon verschiedene unterscheidbare, stratigraphisch konstante *Bolivinoides*-Typen fanden. Dieses Ergebnis legte er 1938 auf der 26." Sitzung für Mikropaläontologie und Stratigraphie" vor. Er konnte so das Mucronaten-Senon in 10 Horizonte aufteilen. Seine 4 Haupttypen bildete er in seinem " *Praktikum der angewandten Mikropaläontologie* " (1942) unter den provisorischen Namen *Bolivina draco*, sim. *draco*, ex. aff. *draco* und cf. *draco* ab. Wicher war davon überzeugt, dass es sich um phyletisch eng zusammenhängende Formen handelt, wartete aber mit einer endgültigen Namengebung bis diese Zusammenhänge geklärt und auch an Proben ausserhalb Nordwest-Deutschlands nachgewiesen werden konnten. Seine Ergebnisse stellte er, soweit es angesichts der Kriegsereignisse noch möglich war, auch ausländischen Fachkollegen zur Verfügung. Es zeigte sich, dass auch in den Alpen, Pyrenäen und Karpaten, in der Kreide Podoliens, des Warthe-und Weichselgebietes in der Aufeinanderfolge der *Bolivinoides*-Typen ähnliche Gesetzmässigkeiten vorlagen: schmale pfriemförmige Anfangstypen führen über breitere Mitteltypen zu breiten drachenförmigen Endformen, bei denen eine betonte Schrägskulptur die Kammerscheidewande völlig verdeckt. Wenn auch der grösste, und wichtigste Teil des Wicher'schen Belegmateriales infolge der Kriegszerstörungen nicht mehr da ist, so haben wir in Hannover inzwischen wieder an die tausend Exemplare sammeln können. Hierauf basierend, mussten wir nach dem Kriege zunächst einmal wieder den Anschluss an die Internationale Nomenklatur haben. Dieses wurde mir durch ausländische Kolleginnen und Kollegen ermöglicht, indem sie mir grossmütig Literatur zur Verfügung stellten. Ich möchte es nicht versäumen, ihnen auch an dieser Stelle meinen Dank zum Ausdruck zu bringen.

Völlig unabhängig von den Arbeiten der Erdölgeologie konnte Wedekind (1940) im westfälischen Santon und Campan bei den Flabellinen analoge phyletische Abänderungen feststellen. Ich möchte aber zunächst die Frage der *Bolivinoides*-Entwicklung zu Ende behandeln, da es an diesem Beispiel am besten unsere Arbeitsmethodik zeigt.

Für unsere 1945 in Hannover wieder aufgenommenen Arbeiten stand von Anfang an die Frage im Vordergrund, wie ist es möglich, für die Oberkreide mit Hilfe der Foraminiferen eine weltweite Stratigraphie zu gewinnen. Es wurde mir dabei immer klarer, dass man methodisch hierbei an die Kenntnisse der Ammonitenpaläontologie anknüpfen muss. Als Beispiel möchte ich hier auf die grundlegenden Arbeiten von Wedekind hinweisen, wo das Ober-und Mitteldevon anhand der Entwicklung bestimmter Clymenien und Goniatiten in Biozonen aufgeteilt wird.

Es bestand für uns kein Zweifel, dass Wicher mit seiner Entwicklung von *Bolivinoides draco* ähnliche Reihen nahverwandter Formen gefunden hatte.

Bei der Untersuchung eines grösseren Materiales stellten sich für mich hier natürlich alle die Schwierigkeiten ein, mit denen auch die Paläontologie der Metazoen zu ringen hat. Es zerfliesst einem im wahrsten Sinne des Wortes alles; es gibt die unglaublichsten Übergänge, wenn nur das Material gross genug ist. Es lässt sich nicht nur zwischen den verschiedenen *Bolivinoides*-Typen ein Ineinanderübergehen feststellen, sondern darüber hinaus auch zu Arten ganz anderer Gattungen. So fanden sich Übergänge bis zur echten *Bolivina decurrens*, *watersi* und zu *Loxostoma*-Arten.

Und trotzdem lassen sich einzelne Typen, um die sich die einzelnen Formen gruppieren, systematisch einwandfrei fassen.

Es stellt sich dabei zwar heraus, dass man nicht alle Merkmale gleichwertig nebeneinander für eine Klassifikation heranziehen darf: Bei den *draco*-Typen Wicher's ändern sich neben dem Umriss (Längen-Breiten-Index) die übrigen Merkmale: Die runden Gruben und Höcker der schmalen Primitivformen machen mehr oder weniger betonten lappenförmigen Kammer-Ausstülpungen oder

Knotenreihen Platz. Bei den breitesten rhombischen Formen schliesslich überdecken fast senkrecht zu den Kammergrenzen stehende, sich verzweigende Rippen oder Knotenreihen die Nähte vollständig. Während zwischen Längen-Breiten-Index, Dicke und Skulptur noch gewisse Korrelationen bestehen, scheint dies bei weiteren Merkmalen nicht der Fall zu sein. Vereinzelt kommen immer mal wieder einzelne Exemplare vor, die eine weniger betonte Skulptur besitzen und dadurch die Kammerwände mehr oder weniger deutlich hervortreten lassen. Häufig hat man den Eindruck, dass dabei Erhaltungszustände vorliegen. In anderen Fällen dagegen muss es sich um ein genetisch verankertes Merkmal handeln. Hier ist es richtig, solche nicht mehr zu *Bolivinoides* zu stellen, wie es ja auch gemeinhin geschieht. Unsere bisherige langwierige taxonomische Bearbeitung hat ergeben, dass bei den *Bolivinoides*-Arten der Oberkreide vor allen anderen Merkmalen dem Umriss die entscheidende taxonomische Bedeutung zukommt. Er ist am einfachsten durch den Längen-Breiten-Index in einer Zahl auszudrücken. Bei Berücksichtigung aller Altersklassen dieses grossen Formenkreises schwankt er zwischen 3 und 1,1. Unter Einrechnung der Messfehlergrenze genügt die Angabe der ersten Stelle hinter dem Komma.* Ich möchte hier noch einen nicht unwichtigen technischen Hinweis geben, worauf auch Wood und Barnard in ihrer vorbildlichen Ophthalmidien-Arbeit (1946) aufmerksam machten: Die Masse sind zweckmässig nicht den Originalexemplaren mit dem Okularmikrometer, sondern den (möglichst in gleichem Massstab) gezeichneten oder photographierten Abbildungen zu entnehmen. Hierdurch wird die Messfehlergrenze auf ein Mindestmass herabgedrückt.

Unter Zugrundelegung des Längen-Breiten-Index kommen wir zu folgendem Ergebnis: Die schmalen Typen (Längen-Breiten-Index 3-2,2) entsprechen der von Cushman aus dem Austinkalk beschriebenen *austinana*. Nach Cushman (1946) stellt sie auch in der amerikanischen Oberkreide die älteste der bisher bekannten, *Bolivinoides* dar. Trotz gewisser skulptureller Unterschiede habe ich den Eindruck, dass es sich bei unseren und den Cushman'schen Formen um die gleiche Art handelt. Dies schliesst natürlich nicht aus, dass verschiedene geographische oder ökologische Formen, wie in diesem Falle, vorliegen können. Es ist charakteristisch, dass sich die vorher schon skizzierten grossen Entwicklungstendenzen der Wicher'schen *draco*-Gruppe schon hier anbahnen. Die ersten in unserem Santon (Granulaten-Senon) erscheinenden Typen sind von den späteren des tiefen Campan (Quadraten-Senon) zu unterscheiden. Die werden allmählich flacher und etwas breiter und zeigen lappenförmige Kammerfortsätze. Entsprechende Angaben finden sich auch in Cushman's Monographie (1946): Seine typischen Exemplare finden sich nur im oberen Austin, weniger typische im unteren Taylor.

Im tiefen Campan (Quadraten-Senon) finden sich daneben schon Mutanten, die sich nach Umriss, Querschnitt und Skulptur nicht mehr zu *austinana* stellen lassen. Sie gehören vielmehr zu *Bolivina decorata delicatula* Cushman. Ich möchte diese stratigraphisch wichtige, von Cushman zuerst aus Trinidad beschriebene Form, nicht wie er als Varietas, sondern als Subspecies auffassen und enger fassen, als er es zum Schluss in seiner Oberkreide-Monographie der Gulf Coastal Region vorschlägt. Die von ihm aus dem Pecan Gap Kalk (Ob. Taylor) und dem Saratoga Kalk abgebildeten breiten Exemplare gehören eher zur *decorata* selbst als zur Subspecies *delicatula*.

Im mittleren bis oberen Campan (oberstes Quadraten-Senon bis unteres Mittel-Mucronaten-Senon) folgt dann individuenmässig die Hauptentfaltung der Gattung *Bolivinoides*. Es ist die von Jones zuerst aus den Kalken von Heady Hill von Ireland beschriebene *decorata*. Jones bildet ein juveniles und ein adultes Exemplar ab, die beide aus dem höheren Campan zu stammen scheinen. Dank dem Entgegenkommen des Kollegen Ellis stand mir die Originalabbildung und Beschreibung aus dem umfangreichen Foraminiferen-Katalog von Ellis & Messina zur Verfügung. Hiernach

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* Diese von Wicher zuerst erkannte Gesetzmässigkeit wurde von Bettenstaedt (1946) in einer übersichtlichen noch unveröffentlichten phyletischen Tabelle zusammengefasst. Ich bin meinem Kollegen Bettenstaedt zu grossem Dank verpflichtet, dass er mir diese als Arbeitsunterlage zur Verfügung stellte. Eine ausführliche Darstellung der Taxonomie mit Synonymik und Variationskurven ist zur Zeit im Jahrbuch des Amtes für Bodenforschung im Druck unter dem Titel: H. Hiltermann & W. Koch: Taxonomie und Vertikalverbreitung von *Bolivinoides*-Arten in N.W.-Deutschland.

handelt es sich um eine etwas ausgefallene Spätform, mit der aber in Übereinstimmung mit allen bisherigen Barbeitern (Cushman, Dajn, Macfadyen, Marie, Plummer, Schijfsma, Subbotina, White u.a.) das Gros der Formen des Campan zusammenzustellen ist. Diese *decorata decorata* ist vor allem bezüglich ihrer Skulptur eine relative weite systematische Einheit. Ihr Längen-Breiten-Index schwankt aber nur zwischen 1,3 und 1,9.

Wie schon die Jones'schen Spätformen erkennen lassen, zeigen die letzten *decorata*–Typen Übergänge zu der breiten rhombischen *draco* Marsson (non *draco* s. str. Wicher) aus dem Maastricht von Rügen.

Es wurde schon von verschiedenen Autoren, auch von Cushman selbst, darauf hingewiesen, dass mit dieser *draco* Marsson auch die auf das Mendez von Mexiko beschränkte *rhomboidea* Cushman eng verwandt ist. Ich halte es mit White u.a. für richtig, beide artlich zusammenzufassen. Die geringen Skulpturunterschiede der wenigen zufällig abgebildeten Exemplare sind nach allen unseren bisherigen Erfahrungen als modifikatorische, aber nicht als phyletische Abweicher aufzufassen. Der Längen-Breiten-Index von *Bolivinoides draco* Marsson schwankt zwischen 1,1 und 1,4.

Im Maastricht schliesslich erreicht die im oberen Campan in zwei Hauptrichtungen erfolgende Entwicklung von *Bolivinoides*, wie Wicher zeigen konnte, in beiden Richtungen ihren Endpunkt in Form von übersteigertem Grössenwachstum. Mit Beginn des Dan stirbt dann die Gattung *Bolivinoides* plötzlich und unvermittelt aus.

Soweit mir bekannt, sind aus jüngeren Ablagerungen als dem Maastricht keine sicheren *Bolivinoides*-Arten mehr beschrieben. Eine der *Bolivinoides texana* Cushman ähnliche Form aus dem dänischen Paläozän ist nach Brotzen (1948) nicht zu *Bolivinoides* zu stellen.

Dieses Eingehen auf die Phylogenie einer geschlossenen Formengruppe war notwendig, um zeigen zu können, dass tatsächlich auch bei den Kleinforaminiferen phyletische Gesetzmässigkeiten vorhanden sind. Ich brauche in diesem Zusammenhang nicht zu betonen, dass die dargestellten Verhältnisse inzwischen in Nordwest-Deutschland in Tausenden von Fällen von einer Reihe von Bearbeitern (Bartenstein, Bettenstaedt, Brand, Buck, Fahrion, Hiltermann, W. Koch, Wicher, Wick, Wolburg u.a.) immer wieder nachgeprüft worden sind und sich bewährt haben.

Als weitere phyletisch abändernde Kleinforaminiferen der Oberkreide verdienen vor allem die Flabellinen* besondere Aufmerksamkeit. Nach langem vergeblichen Suchen fand Wedekind in der westfälischen Oberkreide des Gebietes von Beckum-Soest eine Fazies, die Erfolg für den Ansatz einer diesbezüglichen Grundlagenforschung versprach. Er schlämmte von vielen fossilführenden Fundpunkten je ca. 50 kg. Gestein. Seine Publikation über die papillaten Flabellinen (1940) gibt ein eindrucksvolles Bild von der Phylogenie dieser Formen.

Die ersten echten papillaten Flabellinen zeigen noch keine Mündungsfiguren auf ihren Scheitelzellen. Es sind schon im Emscher auftretende Formen, die sich um die *rugosa* d'Orbigny gruppieren.

Im Santon (Granulaten-Senon) treten schon häufiger Formen auf mit Mündungsfiguren, die zuerst als Mündungszinken, dann vereinzelt schon als Mündungskappen ausgebildet sind. Es gehört hierzu unter anderen *deltoidea pachydisca* Wedekind.

Im unteren und mittleren Campan (Quadraten-Senon) setzt dann eine reiche Entfaltung der papillaten Flabellinen ein. Als besonders charakteristisch tritt die von Wedekind sehr eng gefasste *interpunctata* mit ihren Mutanten hervor. Weiter setzt die reiche Formengruppe der *sphenoidalis* Wedekind ein. Die beiden genannten Typen tragen, ebenso wie die jetzt voll entwickelte *deltoidea* Wedekind (non Marsson) meist schon in der ganzen Ontogenie der Scheitelzellen Mündungskappen.

Im oberen Campan (unteres und mittleres Mucronaten-Senon) sind alle diese Typen nicht mehr vorhanden. Es finden sich stattdessen mindestens zwei verschiedene Entwicklungsrichtungen nebeneinander. Einmal erscheinen Formen, wie *leptodisca* Wedekind, die fast immer vollständige,

* Der Name *Flabellina* d'Orbigny 1893 braucht nach den neuesten noch unveröffentlichten Untersuchungen von dem Kollegen Bartenstein nicht zugunsten von *Palmula* Lea 1833 eingezogen zu werden. Letzterer bleibt für primitivere Arten, wie *cordata* Reuss, *elliptica* Nilsson, *obliqua* und *ovata* v. Münster, *pilulata* Cushman und andere vorbehalten.

sogar zum Teil auf die Spiralwindung übergreifende Mündungskappen zeigen bei einem Umriss, wie er sich erst bei der späteren *reticulata* Reuss findet. Daneben treten sogar schon Formen auf, die in ihren senilen Windungen die typische geordnete Gitterstruktur der *reticulata* zeigen. Fast gleichzeitig taucht eine ganz andersartige geschlossene Formen gruppe auf, die der *Flabellina efferata* und *numismalis* Wedekind. Ich möchte sie als Endglied einer Entwicklungsreihe auffassen, wo viele früheren Merkmale bizarr und überspitzt erscheinen. Die Mündungskammern sind verdoppelt oder vervierfacht, die vorher deutlich ausgebildeten Rippen werden undeutlich und verschwinden zugunsten eines anscheinend regellos angeordneten Gitterwerkes. Wahrscheinlich gehören auch die von Marie beschriebene *coranica* und *lacostei* hierzu, was aber noch am Material nachzuprüfen ist. Auch zwischen der von Mrs. Plummer emendierten *Flabellina projecta* Carsey aus Texas und der Wedekind'schen *numismalis* scheinen engste verwandtschaftliche Beziehungen zu bestehen, falls beide nicht überhaupt zu einer species gerechnet werden müssen, was eine Einziehung des Wedekind 'schen Artnamens zur Folge hätte.

Dass sich die echte von Reuss zuerst aus der Lemberger Kreide beschriebene *reticulata* als hervorragendes Leitfossil des Maastricht bewährt hat, braucht mit Rücksicht auf die vielen hierüber schon vorhandenen Literaturangaben nicht ausgeführt zu werden. Besondere Mündungskappen sind bei diesen grosswüchsigen Endformen meist nicht mehr vorhanden.

Ich darf nicht verschweigen, dass noch viele Fragen offen liegen. Ganz abgesehen davon, dass die Wedekind'sche Nomenklatur sich nicht nach den internationalen Nomenklaturregeln richtet und vor allem in vielen wichtigen anderen Punkten keineswegs befriedigt; so ist eine sichere Unterscheidung von *pachydisca* und *rhombica* Wedekind in vielen Fällen noch nicht eindeutig möglich; in Einzelfällen sind durchlaufende Formen noch nicht eindeutig von horizontbeständigen Formen zu trennen; die sich um die postsenonen Nachzügler, wie die *Flabellina delicatissima* Plummer aus der Midway Formation, gruppierenden Fragen sind noch ungeklärt.

Aber alle diese Einwände können das Bestehen der von Wedekind entdeckten Grundtendenz der Flabellinen-Entwicklung nicht mehr erschüttern. Das von meinen Mitarbeitern und mir bearbeitete Probenmaterial stammt keineswegs nur aus dem nordwest-europäischen Raum. Es kommen zu diesen Proben noch die von Frl. Altaner und mir in der podolischen Kreide und im Karpatenflysch und von Bartenstein in Südfrankreich durchgearbeiteten Profilserien hinzu. Ausserdem standen mir neben aussereuropäischem Material aus dem Senckenberg-Museum mir liebenswürdigerweise von Mrs. Plummer aus Texas überlassene Schlämmrückstände zur Verfügung.

Auch bei diesem zweiten Beispiel musste von den vielen ein Merkmal als Ordnungsprinzip herausgegriffen werden; die Mündungsfiguren. Die übrigen Merkmale, wie Umriss, Dicke, Punktierung und Lage und Form der Spira haben sich hierfür als nicht so brauchbar erwiesen. Man kann dieser Beobachtung sogar einen gewissen biologischen Sinn geben. Es kann die immer vom Plasma umgebene Mündung durchaus bevorzugt phyletisch verankerte Merkmale aufweisen.

Die Flabellinen stellen auch in anderer Beziehung gute Studienobjekte dar, da sie zu den wenigen fossilen Tiergruppen gehören, bei denen Schalenmerkmale der Jugendstadien auch im adulten Zustand der Untersuchung zugänglich sind. Ich möchte daran erinnern, dass meist keinerlei Fixierung der ontogenetischen Frühstadien stattfindet. Und wo es der Fall ist, wie z.B. bei den Ammoniten, da sind der Anwendbarkeit Grenzen gesetzt durch das schwierige und langwierige Herauspräparieren der Innenwindungen. Bei den Flabellinen konnten wir die oben gemachten Angaben über den Entwicklungsgang bestimmter Merkmale immer wieder ontogentisch nachprüfen. Ich hoffe, diese und andere paläontologische Untersuchungen bald zu beenden und publizieren zu können.

Zu beachten ist ferner, dass sich am Rande solcher Untersuchungen viele für die allgemeine Paläontologie und Biologie wichtige Erkenntnisse ergeben. Wicher (1947) wies schon hin, dass sich das auffällige Grössenwachstum der Endformen von *Bolivinoides decorata* und *draco* analog auch bei *Bolivina incrassata* findet; nur mit dem Unterschied, dass die grosse auch von Wicher (1942) Tafel 26, Figur 22 schon abgebildete Unterart von *incrassata* später als die grossen *Bolivinoides*-Arten

ausstirbt. Auch die *Flabellina reticulata* stellt zweifellos die grosswüchsigste Art der papillaten Flabellinen dar, die kurz vor dem Aussterben dieser merkwürdigen Foraminiferengattung erscheinen. Wie Wood und Barnard in ihrer schon zitierten Studie über *Ophthalmidium* nachwiesen, bieten die Kleinforaminiferen aus verschiedenen Gründen ausgezeichnete Objekte für die Klärung solcher Fragen.

Ich bin nach allem überzeugt, dass sich auch in anderen Gattungen der Oberkreide Arten mit ähnlichen Gesetzmässigkeiten finden. Nach den von Glaessner begonnenen und vor allem von den Schweizer Kollegen fortgesetzten Arbeiten sind hierfür die Globotruncanen zu nennen. Auch bei *Stensiöina exsculpta*, bei vielen Frondicularien, bei *Bolivina incrassata* zeigen sich Frühformen, die sich stufenweise und gerichtet bis zu ihrem Aussterben orthogenetisch abwandeln. Erfahrungsgemäss liegen in allen diesen genannten Formen bewährte Leitfossilien vor, die genau so biostratigraphisch verwendbar sind, wie viele Ammoniten.

Hiermit möchte ich die Behandlung der Oberkreideforaminiferen abschliessen. Als Schlussfolgerung aus den hier kurz behandelten Problemen der Oberkreide und unseren Erfahrungen, die wir in anderen Formationen machen konnten, sollen noch kurz einige allgemeine Leitsätze für die Anwendung von Mikrofossilien für die Stratigraphie gegeben werden:

(1) Für regional begrenzte Gebiete genügt im allgemeinen für eine sichere Horizontierung unter Benutzung der anderen hervorstechenden Charakteristika des Schlämmrückstandes eine weite Artfassung. Häufig führt sogar in diesem Falle eine behelfsmässige offene Nomenklatur oder Ziffernnomenklatur zum Ziel.

(2) Für eine weiträumige Geochronologie dagegen versagen hier wie bei den Grossfossilien die Methoden der üblichen Leitfossillehre oder des blossen Faunenvergleiches. Darüber hinaus ist hierfür die phyletische Entwicklung einzelner Arten zu benutzen.

(3) Eine Stratigraphie ist mit Foraminiferen ebenso möglich wie mit Grossfossilien und anderen Mikrofossilien, wie etwa den Ostracoden.

(4) Die Mikrofossilien haben gegenüber den Grossfossilien den Vorteil der grösseren Häufigkeit ihres Vorkommens, was aber nicht heisst, dass die häufigsten Foraminiferen auch die geeignetsten Leitfossilien sind.

(5) Welchen der in einer Schichtenfolge zu beobachtenden Leitfossilien das Primat zukommt, richtet sich nach der unter (1) und (2) angeführten Fragestellung. Dies kann erst auf Grund mehrerer vergleichbarer Vertikalverbreitungstabellen entschieden werden. Für unsere Oberkreide sind es bestimmte Foraminiferenarten bzw. Artenreihen.

(6) Auch bei relativ einheitlicher Faziesfolge, wie in der nordwest-deutschen Oberkreide, wird es durch Berücksichtigung der Foraminiferen wesentlich erleichtert, minutiöse Faziesschwankungen zu fassen.

(7) Für eine regionale Stratigraphie besteht für die Anwendung der Foraminiferen dieselbe grundsätzliche Voraussetzung, nämlich eine einwandfreie regional gültige Taxonomie, die sich auf sorgfältigste morphologische Analyse der Ontogenie und Phylogenie an möglichst grossem Material stützen muss. Dass dabei die internationalen Nomenklaturregeln zugrunde zu legen sind, braucht in diesem Zusammenhang nicht besonders betont zu werden.

(8) Eine solche Taxonomie ist mit einem möglichst umfangreichen feinstratigraphisch entnommenen Vergleichsmaterial aufzustellen. Die Literatur ist wegen der ausserordentlichen Ungleichwertigkeit des Ausgangsmateriales und durch die sehr verschiedene Handhabung des Artbegriffes nur mit kritischer Vorsicht heranzuziehen.

(9) Vor der Aufstellung von neuen taxonomischen Einheiten ist die ganze Formengruppe einer vergleichend paläontologischen Untersuchung zu unterziehen, wobei, wie überall in der Paläontologie, neben paläontologischen auch die stratigraphischen Gesichtspunkte zu berücksichtigen sind.

(10) In den meisten Fällen wird es sich als richtig erweisen, nicht irgendwelche Merkmale je nach ihrer Auffälligkeit oder betonten Ausbildung der Taxonomie zugrunde zu legen, sondern das günstigste als Ordnungsprinzip auszuwählen.

(11) Den Foraminiferen-Gattungen kommt für solche biostratigraphischen Fragen im Vergleich zu den Arten keine Bedeutung zu. Dagegen spielen neben den Arten niedrige taxonomische Einheiten eine entscheidende Rolle.

(12) Bei den biostratigraphisch wichtigen Arten ist analog der Ammoniten-Paläontologie besser ein enger als ein zu weiter Artbegriff zu verwenden.

SCHRIFTENVERZEICHNIS

Es kann hier nur eine kleine Auswahl der wichtigsten Arbeiten gebracht werden. Weitere Hinweise finden sich in den aufgeführten Publikationen.

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SUR L'ÉVOLUTION DE LA FAUNE DE FORAMINIFÈRES DES COUCHES DE PASSAGE DU CRÉTACE AU TERTIAIRE

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Communiqué par J. Roger (France)

ABSTRACT

L'étude de la faune de foraminifères renfermée dans les formations de passage du Crétacé au Tertiaire recueillies dans les localités types (Bassin Franco-Belge, Limbourg, Hollandais et Danemark) s'avère des plus instructives, tant au point de vue évolutif générale qu'à celui de la richesse des formes et permet d'entrevoir une solution sinon définitive, du moins satisfaisante aux nombreux problèmes soulevés dans le monde entier par la corrélation entre elles de ces formations.

Au point de vue évolutif, cette étude montre qu'entre deux longues périodes pendant lesquelles l'évolution générique de la microfaune reste normale, s'intercalle un bref épisode révolutionnaire au cours duquel la presque totalité des genres préexistants se trouvent profondément et radicalement modifiés.

Ce paroxisme évolutif se traduit chez la plupart des foraminifères de la famille des Valvulinidae par un développement démesuré de la largeur de l'ouverture qui d'étroite et virgulaire qu'elle était au Danien devient des la base du Montien, large et préservée d'une dent susaperturale comme chez les *Valvulina.*

Par contre chez les foraminifères calcaires ce paroxisme évolutif se manifeste par une exagération du système canaliculaire préexistant ou par l'apparition de système canaliculaire supplémentaire ou enfin par le développement d'ouvertures secondaires.

La microfaune du Danien plus pauvre génériquement que celle du Maestrichtien ne renferme, à l'exception peut être des *Annulofrondicularia* que des genres ayant déjà existé dans les étages supérieurs du Crétacé.

Par contre la microfaune du Montien, qui ne renferme peut-être qu'un seul et unique genre originaire du Crétacé (*Coleites*) est caractèrisée par l'apparition d'un grand nombre de genres nouveaux *Valvulina*, *Miscellanea*, *Laffitteina*, *Scarificatina*, *Bigeneropolis*, *Epistomaria*, etc.,) dont la majorité évoluera au cours du Tertiaire.

Ces observations ne semblent pas être spéciales aux seules régions Nord-Européennes. Malheureusement si la distinction entre Danien et Montien s'avère facilitée, celle entre Montien et Thanétien nette dans les bassins Nord-Européens, demande encore de plus amples études avant d'en généraliser les conclusions.

MIKROPALÄONTOLOGIE UND STRATIGRAPHIE IN DEN TERTIÄREN BECKEN UND IN DER FLYSCHZONE VON ÖSTERREICH

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ABSTRACT

Durch die älteren Arbeiten von d'Orbigny, Czjzek, Reuss, Karrer und anderen Forschern wurde der Mikrofossilreichtum der tortonischen Schichten des Wiener Beckens allgemein bekannt. In den dreissiger Jahren unseres Jahrhunderts begann in Österreich eine verstärkte Aufschlusstätigkeit auf Erdöl und Erdgas, in derem Gefolge auch die Mikropaläontologie massgeblich eingesetzt ist. Während die älteren Untersuchungen nur Teile der Füllung des Wiener Beckens erfassten, da sie im wesentlichen auf die randlichen Aufschlüsse beschränkt waren, liegen heute zahlreiche vollständige Profile aus allen Beckenteilen vor, die einen guten Einblick in deren stratigraphischen Aufbau gewähren.

Der den älteren Autoren im Wiener Becken noch unbekannte, das Torton unterlagernde marine helvetische Schlier führt eine im allgemeinen vom Torton recht verschiedene, kleinwüchsige Mikrofauna, deren zonenweise wechselndes Gepräge wichtige Hinweise für den Entwicklungsgang des Beckens gibt. Bezeichnenderweise schliessen nach oben zu viele Profile mit äusserst armen oder mikrofossilfreien Proben. Auch das Torton zeigt im ganzen gesehen eine Entwicklung von reichen Proben im tieferen Teil, für den die prachtvollen Badener Faunen kennzeichnend sind, zu artenarmen Zonen im Hangenden, die ins brackische Sarmat überleiten, das mikropaläontologisch noch gut aufzugliedern ist. Die Congerienschichten des Pannons wurden von verschiedenen Bearbeitern (H. Fahrion, V. Pokorny in Südmähren) vorzüglich nach Ostracoden gegliedert.

Für die mächtigen Schlierablagerungen des Molassebereichs hat die Mikropaläontologie viele Klärungen gebracht. Derzeit sind umfangreiche Untersuchungen, auch durch andere Autoren, in der Flyschzone im Gange. Die von M. Richter und G. Müller-Deile erstmals skizzierten Aufbrüche von Kreide- und Eozänschichten des Helvetikums wurden auch mikropaläontologisch schärfer erfasst. Die Faunen der in Aufgliederung befindlichen äusserst fossilreichen Ablagerungen (insbesondere mit zahlreichen Globotruncanen, Gümbelinen und Pseudotextularien) haben nichts mit den zum grösseren Teil aus agglutinierenden Formen bestehenden Flyschfaunen gemeinsam, und die in der Literatur vielfach auf Grund einer äusseren lithologischen Ahnlichkeit (z.B. bunte Fazies) durchgeführten Schichtenparallelisierungen sind nicht richtig.

IM Rahmen dieser Mitteilung soll nur auf die im Titel genannten geologischen Räume eingegangen werden, die in den letzten Jahrzehnten grösstenteils im Zusammenhang mit der Erdölsuche teilweise sehr eingehend studiert wurden. Die tertiären Becken begleiten den Alpenkörper am Aussenrand oder sie sind diesem als junge Einbrüche eingeschaltet. Das österreichische Alpenvorland und das Ausseralpine Wiener Becken sind ein Stück der Molassezone, das nach Westen seine Fortsetzung in der süd-deutschen Hochebene und im Mittelland der Schweiz findet und im Nordosten sich über den Bečva Graben und die Senke von Mährisch Ostrau mit dem galizischen Karpatenvorland verbindet. Das Inneralpine Wiener Becken senkt sich an einem System von Brüchen von z.T. bedeutender Sprunghöhe innerhalb der Alpen bzw. Karpaten ein. Am Alpenostrand bricht das Grazer Becken ab. Auch der vorzüglich aus Kreide-und Alttertiärsedimenten aufgebauten alpin-karpatischen Flyschzone wendet sich ein stetig wachsendes Interesse zu, wenn auch hier die Aufschlussarbeiten bei weitem noch nicht das Ausmass erreicht haben, wie in den tertiären Becken. Aber gerade die schwierigen stratigraphischen Verhältnisse, die in allen Flyschablagerungen vorliegen, und die verwickelte Tektonik machen den Einsatz von feineren Methoden, wie insbesondere der Mikropaläontologie, doppelt nötig.

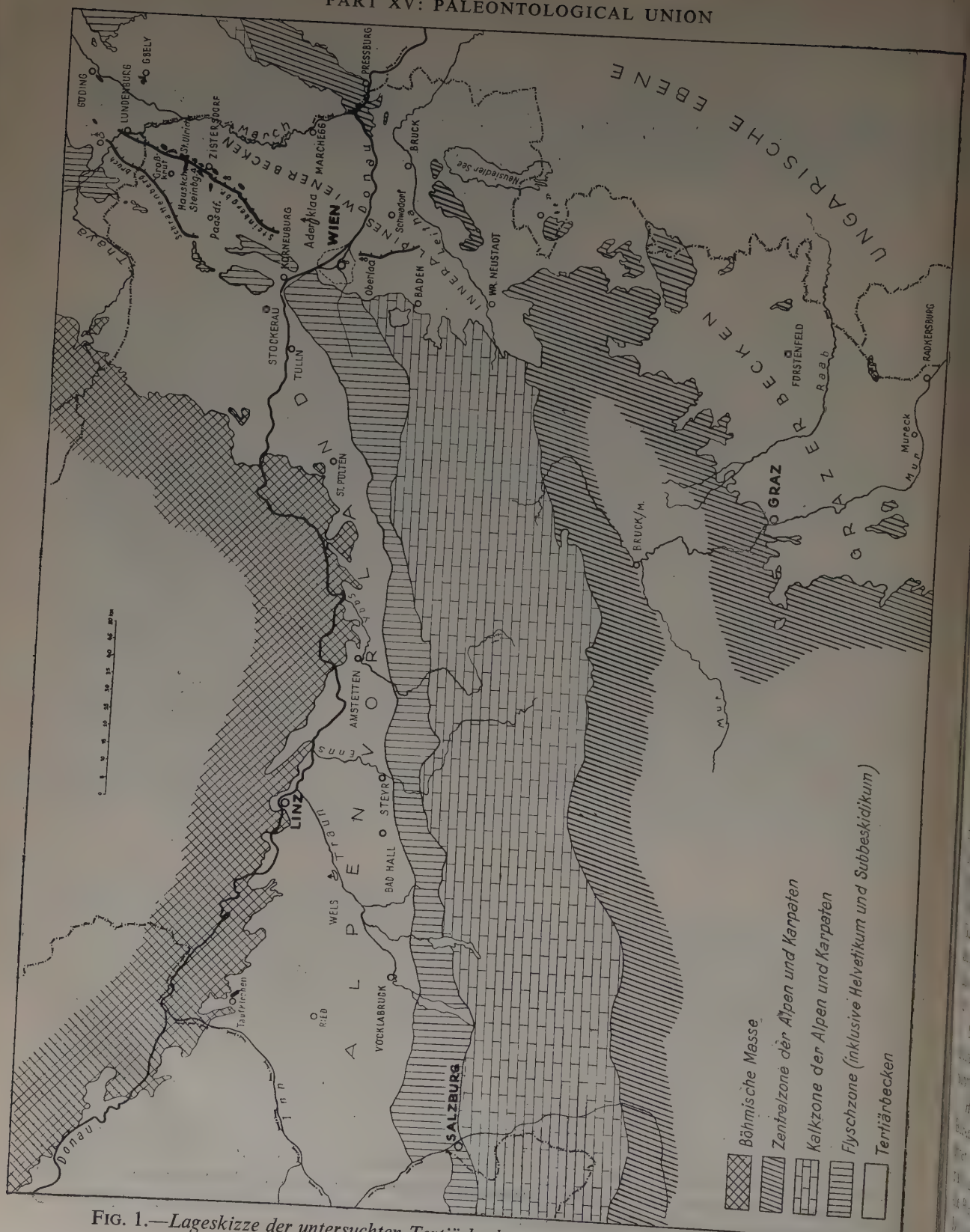

FIG. 1.—*Lageskizze der untersuchten Tertiärbecken und der Flyschzone von Österreich.*

Durch eine stattliche Reihe von Arbeiten ist der Mikrofossilreichtum der österreichischen Jungtertiärablagerungen auf der ganzen Welt bekannt geworden. Durch A. d'Orbigny wurden 1846 die von J. Hauer entdeckten Foraminiferen vorzüglich der tortonischen Ablagerungen von Nussdorf und Baden bei Wien beschrieben. Zahlreiche Arbeiten von J. Čžjžek, A. E. Reuss, F. Karrer u.a. aus der zweiten Hälfte des vorigen Jahrhunderts beleuchten den Mikrofossilinhalt der verschiedenen Beckenglieder nach dem damaligen Stand der Forschung. Aus späterer Zeit sei vor allem auf die Arbeiten von F. Toula, R. J. Schubert und R. Jaeger hingewiesen. Das Verdienst des letztgenannten besteht vor allem darin, zahlreiche Fossilfunde in den ansonst sehr fossilarmen Flyschablagerungen gemacht zu haben. Später waren es vor allem G. Götzinger und H. Becker, die durch neue Fossilfunde unsere Kenntnis der Flyschzone vermehrten. Soweit Foraminiferen entdeckt wurden, handelt es sich, wie auch bei Jaeger, meist um Grossforaminiferen, auf die aber in dieser Abhandlung nicht näher eingegangen werden soll. Eine systematische Durchsuchung der Flyschablagerungen nach Kleinforaminiferenfaunen fand nicht statt.

Die mit dem Studium der tertiären Beckensedimente beschäftigten Forscher erfassten nur einen Teil derselben, da sie, wie etwa im Wiener Becken, die tieferen Glieder im allgemeinen nur insoweit untersuchen konnten, als sie randlich ausstreichen. Auch war die Anzahl der von ihnen beschriebenen Proben naturgemäss beschränkt. Erst mit dem Beginn der Erdölerschliessungsarbeiten setzte eine systematische Aufsammlungstätigkeit ein. Das heute für die Kenntnis der tertiären Ablagerungsräume grundlegende Material stammt aber aus den Hunderten von Tief-und Flachbohrungen, die alle Beckenteile erfassten und damit einen klaren Einblick in deren stratigraphischen Aufbau gewähren.

Die erste Firma, die in Österreich ein mikropaläontologisches Laboratorium einrichtete, war die European Gas and Electric Company (Eurogasco). Sie machte in den Jahren 1932-1936 umfangreiche Untersuchungen in den verschiedenen tertiären Beckenräumen und liess die zahlreichen Feld-und Bohrproben auch nach ihren Mikrofaunen hin untersuchen. V. Petters und H. Bürgl stellten ein Normalmikroprofil des Gasdoms von Oberlaa bei Wien auf. Denselben Autoren gelang auch eine mikropaläontologische Gliederung der Schlierablagerungen des Alpenvorlandes von Oberösterreich. Auch weitere Firmen richteten sich in späteren Jahren Schlämmlaboratorien ein. Der einheitlichen mikropaläontologischen Durcharbeitung der Erdölgebiete Osterreichs widmet sich vor allem die Geologische Bundesanstalt in Wien, die über einen modernen Arbeitsapparat verfügt.

WIENER BECKEN

Die mikropaläontologische Untersuchung der wichtigsten Jungtertiärprofile des Wiener Beckens zeigte auch innerhalb der einzelnen Stufen einen beträchtlichen Wechsel in der vertikalen Fossilfolge auf, der im ganzen gesehen über grössere Gebiete gleichartig ist und daher stratigraphisch von Bedeutung ist. Vorzüglich sind es die Artenvergesellschaftungen, die regelmässige Veränderungen aufweisen. Sie wurden durch die wechselnden Umweltsverhältnisse bedingt und spiegeln damit die geologische Geschichte des Wiener Beckens wider; damit eröffnen sich aber auch Aussichten auf die benachbarten Becken, soweit sie einen ähnlichen Entwicklungsgang genommen haben. Tatsächlich konnten für das Torton und für das Sarmat, insbesondere aber für das Pannon auch solche Parallelisierungen schon angedeutet werden.

Das wichtigste Material für die vorliegenden Untersuchungen lieferten die Foraminiferen. Aber auch die anderen tierischen und pflanzlichen Überreste durften nicht vernachlässigt werden, wie etwa Schwammnadeln, Otolithen, Diatomeen, besonders aber auch die Kleinmollusken.

Helvet.—Auf dem alpin-karpatischen Untergrund liegen als älteste Glieder der jungtertiären Beckenfüllung marine und marin-brackische, seltener auch limnische Ablagerungen, die zufolge ihrer von den überlagernden Schichtgliedern abweichenden Fazies, ihrer von dieser abweichenden paläogeographischen Verbreitung und tektonischen Stellung (R. Janoschek, 1943) und wovon hier die Rede sein soll, zufolge ihrer Fauna ins untere Mittelmiozän, ins Helvet gestellt werden müssen. Das kennzeichnendste Glied dieses Schichtstosses ist der sogenannte Schlier, ein mariner, einförmiger, grauer, meist sandigglimmeriger Tonmergel, der bei typischer Entwicklung sehr gut geschichtet ist

und dünne, sandige Schichtbeläge aufweist. Brauchbare Makrofossilien sind selten und meist nur in sandig-konglomeratischen Einschaltungen. Dem Flyschuntergrund liegt er mit einer nicht selten mehrere hundert Meter mächtigen Basisbrekzie aus aufgearbeitetem Flyschgestein (Flyschschutt) auf. Durch Einlagerung mächtiger Sande geht der Schlier in die Entwicklung der als Grunder Schichten bezeichneten Fazies über, die vielfach einen brackischen Einschlag aufweist.

Die Mächtigkeit von Schlier und Grunder Schichten des Wiener Beckens ebenso wie die ihrer Basis schwankt ausserordentlich, was nicht zuletzt auch darauf zurückzuführen ist, dass diese dem stark reliefierten alpin-karpatischen Untergrund als ältestes Jungtertiärglied aufliegen. Als maximale Mächtigkeit wurde bislang in Bohrungen ein Betrag von 800 m. nachgewiesen. Der Wunsch nach einer Feingliederung dieser Serie ist umso naheliegender, als sie wichtige Öl-und Gaslager birgt. Anderseits war das Alter der Ablagerungen faunistisch zu beweisen.

Im grossen gesehen konnte bei den verschiedenen Schlierprofilen der Mistelbacher Scholle, d.i. das Gebiet zwischen Schrattenberg-und Steinbergbruch, die Beobachtung gemacht werden, dass die tieferen Partien die reicheren Mikrofaunen führen und nach oben zu eine Verarmung festzustellen ist. Auch das Grössenwachstum der Foraminiferen ist im allgemeinen im tieferen Schlier ein besseres als im höheren; die Lebensbedingungen wurden also im Verlaufe der Schliersedimentation ungünstiger, bis es schliesslich selbst zur Bildung fossilfreier Schlammabsätze kam. Nicht zuletzt scheint dabei der Durchlüftungsfaktor eine bedeutsame Rolle gespielt zu haben. Kennzeichnend für die Faunen der tiefsten Schlierabteilung der Strukturen Grosskrut und Paasdorf, des Feldes Hauskirchen—St. Ulrich u.a. ist, dass sich an ihrer Zusammensetzung auch agglutinierende Formen beteiligen. Verschiedene Arten der Gattung *Cyclammina* (*C. acutidorsata*, *C. miocaenica*) und *Bathysiphon* sind kennzeichnend und es kann daher auch von einem *Cyclammina- Bathysiphon-* Schlier gesprochen werden. Im Feld Hauskirchen fanden sich in Schliermergeln, die dem Basisschutt zwischengelagert sind, reiche, grosswüchsige Faunen mit *Robulus*, *Dentalina*, *Nodosaria*, *Marginulina*, *Nonion*, *Elphidium*, *Gyroidina*, *Cibicides* sowie *Cyclammina*, *Bathysiphon* u.a., die Lebensverhältnisse widerspiegeln, wie sie ähnlich auch im tieferen Torton bestanden haben.

Den überlagernden Schlier kann man nach den bezeichnendsten Foraminiferenarten am besten als *Cibicides- Elphidium-* Schlier benennen. *Cibicides* ist in den Faunen durch mehrere Arten vertreten: *C. dutemplei*, *C. lobatulus*, *C. boueanus*, sowie eine durch einen Nabelknopf charakterisierte Art. Die Gattung *Elphidium* tritt mit *E. crispum* und *E. fichtelianum* auf. Ferner seien *Discorbis* und glattschalige Arten von *Robulus* erwähnt, weiters *Textularia deperdita*, *T.* ex gr. *subangulata; Listerella*, *Dentalina* spp., *Nodosaria* spp., *Guttulina austriaca*, *Nonion* ex gr. *commune*, *Bolivina* spp., *Gyroidina soldanii*, *Rotalia beccarii*, *Siphonina fimbriata*, *Pullenia sphaeroides*, *Sphaeroidina bulloides*, *Globigerina* spp. u.a. Schwammnadeln und Fischreste, sowie Seeigelstacheln sind nicht selten. Die Foraminiferen sind im allgemeinen kleinwüchsig und es ist dies ein sehr charakteristischer Zug der Faunen. Solche mit besserem Wachstum schieben sich nur in sehr untergeordnetem Ausmasse ein und knüpfen sich an sandig-konglomeratische Lagen. Recht bezeichnend ist auch, dass verschiedentlich Bryozoen in stärkerer Entwicklung festzustellen sind.

Faunen von der oben angegeben Zusammensetzung sind auch in der unteren Schlierabteilung als Einlagerung zwischen die *Cyclammina-Bathysiphon* Vergesellschaftungen verbreitet, wie hier auch diese beiden Leitformen selbst vielfach mit den kleinwüchsigen *Cibicides-Elphidium* Formen und ihren Begleitern zusammen gehen.

Eine obere Schlierabteilung wird zweckmässig als fossilarmer Schlier bezeichnet. Er führt eine nur äusserst dürftige Foraminiferenfauna und auch andere Fossilreste sind selten. Nur Schwammnadeln sind neben Fischresten besonders in seinem tieferen Teil reichlich vertreten. Die höchsten Schlierproben sind vielfach völlig fossilleer.

Dieser fossilarme Schlier wurde am Steinberg in einer Mächtigkeit bis zu mehreren hundert Metern beobachtet. Auffällig ist, dass hier die Faunen mit *Cyclammina* und *Bathysiphon* lokal nicht beobachtet wurden, dass die betreffende Schlierpartie also auf diesem Hochgebiet offensichtlich nicht zur Ablagerung kam, es sei denn, dass die Äquivalente im Basisschutt zu suchen sind. Wesentlich weniger

mächtig ist der fossilarme Schlier im Bereich der Struktur Grosskrut. Grössere Stärke erreicht er wieder in Paasdorf.

Die Mächtigkeit der einzelnen Abteilungen schwankt von Struktur zu Struktur nicht nur absolut in weiten Grenzen, sondern es lassen sich auch bedeutsame relative Verschiebungen innerhalb der Zonen feststellen, was bei Berücksichtigung des ausserordentlich stark akzentuierten Untergrundes, der zugeschüttet wurde und ferner von gleichzeitigen Absenkungsvorgängen, die partienweise mit Bestimmtheit anzunehmen sind, nicht weiter verwundern kann.

In den Bohrungen Wilfersdorf ca. 10km. westl. des Steinberges tritt der Schlier gegenüber einer sandigen Vertretung weitgehend zurück. Auch hier kann man eine obere fossilarme Partie bemerken, die von mikrofossilreicheren Schichten unterlagert ist, für die wieder die *Cibicides-Elphidium* Faunen kennzeichnend sind. Dazu kommen noch Lagen mit *Rotalia beccarii* als hervortretendste Foraminifere, wie sie typisch in den sandigen Schliervertretungen von Paasdorf und weiterhin auftreten.

Da in Paasdorf in einer Anzahl von Bohrungen auf engem Gebiet der mergelige Schlier durch die sandige Grunder Fazies abgelöst wird, konnte gerade hier der damit verbundene Faunenwechsel gut studiert werden. Soweit Mikrofossilien in brauchbarer Menge vorhanden sind, tritt an die Stelle der oben geschilderten Schlierfaunen eine Rotalienfauna. *Rotalia beccarii* ist vielfach häufig und in einer Entwicklung, wie man sie auch im Sarmat zu sehen gewöhnt ist; doch treten auch grosswüchsige Exemplare auf, wie sie den obertortonischen Schichten eigen sind. Dazu kommen noch verschiedene Milioliden und Ostracoden, besonders *Cytheridea* aff. *mülleri*. Unter den Kleinmollusken sind Neritinen, Hydrobien und Cerithien bemerkenswert. Faunen desselben Charakters führt aber auch das Profil der im Korneuburger Becken niedergebrachten Bohrung Korneuburg 1. Da dieses aber nach den an benachbarten Lokalitäten gefundenen reichen Molluskenfaunen ins Helvet gestellt wird, kann ein solches Alter auch für den Schlier bzw. dessen sandige Vertretung im Wiener Becken zurecht angenommen werden. Damit stimmt auch die durch E. Veit (1943) bekanntgemachte Molluskenfauna der Bohrung Alt-Lichtenwarth 1 überein, die den Charakter der helvetischen Schlierfauna von Ottnang in Oberösterreich aufweist. Dazu kommt, dass nach der früher gegebenen Darstellung mit dem Ende der Schlierablagerung im Wiener Becken ganz offensichtlich eine Sedimentationsfolge zum Abschluss kommt. Das Torton weist eine eigene, ebenfalls durch einige Stadien charakterisierte Entwicklung auf, die in den Mikrofaunen deutlich zum Ausdruck kommt. Gewisse Übergänge aus dem Schlier, die beobachtet wurden, sind damit ohne weiteres vereinbar.

Die von den oben behandelten Ausbildungen des Helvets völlig abweichende Tonmergel-Sandsteinserie von Aderklaa NE. Wien, die im Liegenden eines tortonischen Transgressionskonglomerats mit über 600m. Mächtigkeit auftritt, mag vielleicht einen Hinweis geben, in welcher Fazies das untere Mittelmiozän im südlichen Wiener Becken zu erwarten ist, in dem es bisher noch nicht erbohrt wurde. Ausser Bruchstücken von dünnschaligen Ostracoden fanden sich im fraglichen Profilbereich von Aderklaa keine weiteren brauchbaren Fossilreste, so dass wohl bereits in diesem Teil des Wiener Beckens mit weitgehenden Süsswassereinflüssen zu rechnen ist.

Torton.—Soweit das Torton die helvetischen Schichten nicht überlagert, ruht es direkt auf den alpinen Gesteinen des Untergrundes. Der Leithakalk als Seichtwasserbildung und der Badener Tegel, eine Ablagerung tieferen Wassers, sind die zwei bekanntesten Faziesbildungen im Bereich des Beckens. Durch die Erdöltiefbohrungen bekam man erst einen richtigen Einblick über die Entwicklung der Stufe im Beckeninnern, wo sie in einer Mächtigkeit von rund 1200m. nachgewiesen ist.

Am Steinbergdom wurden im Hangenden des fossilarmen Schliers und von diesem ziemlich scharf abgegrenzt in den Tonmergeln und sandigen Tonmergeln Foraminiferenfaunen gefunden, die im ganzen als ärmlich und kleinwüchsig anzusprechen sind und für die eine schlanke und kleinwüchsige *Uvigerina* (*Uvigerina bononiensis*) charakteristisch ist neben *Robulus inornatus*, *Cibicides* u.a. Foraminiferen. Die nach dem lithologischen Befund der Kerne und nach dem Schlumbergerdiagramm hier gewählte Grenze Torton-Helvet ist also mikrostratigraphisch scharf. Anderseits vermittelt die Fauna mit *Uvigerina bononiensis* durch ihre Zusammensetzung und die Wuchsform der einzelnen

Komponenten doch zwischen Schlierfaunen und den reichen, grosswüchsigen Lagenidenfaunen, die sie überlagern.

Diese Lagenidenzone ist z.B. in Maustrenk 1 am Steinbergdom rund 140m. mächtig und ist ausgezeichnet durch grosswüchsige Formen von *Robulus* spp. *Vaginulina* aff. *margaritifera*, *Dentalina*, *Nodosaria*, *Frondicularia*, *Uvigerina*, *Bulimina*, *Cibicides*, *Planulina*; *Eponides*, *Valvulineria*, *Globigerina*, *Pullenia*, *Nonion*, *Listerella* u.a. Es sind die Formen des tieferen Wassers, wie sie für den Badener Tegel kennzeichnend sind. Ausgesprochene Seichtwasserforaminiferen fehlen und es zeigt sich keinerlei Übergang zu der das Profil abschliessenden Lithothammnienkalkdecke, die vom Steinberg aus Oberflächenaufschlüssen seit langem bekannt ist und deren Mikrofauna ähnlich der von Nussdorf beschriebenen ist. Der etwa 25m. mächtige Kalk mag eine fazielle Vertretung der andernorts beobachteten höheren Tortonzonen sein. Für diese ist kennzeichnend, dass die Mikrofaunen gegenüber der Lagenidenzone im Liegenden, wie sie ausser am Steinberg noch in einer ganzen Reihe von Profilen beobachtet wurde, zunächst insoferne ärmer sind, als die Lageniden völlig zurücktreten und im wesentlichen nur die Begleitformen entwickelt sind, die allerdings noch sehr reiche Faunen zusammensetzen. Die ruckweise Verarmung schreitet aber nach oben zu fort und leitet in Oberlaa z.B. über Proben mit reichlich *Bolivina dilatata* und einigen wenigen Begleitformen und schliesslich über Proben mit *Rotalia beccarii* und *Cibicides lobatulus* ins Sarmat über. Diese Verhältnisse wurden in früheren Veröffentlichungen genauer dargestellt. (R. Grill, 1941, 1943). Sie sind ein getreues Spiegelbild dieses Abschnittes in der Geschichte des Wiener Beckens. Mit Flachwasserablagerungen, die einen entschieden brackischen Einschlag aufweisen, endet die Stufe, deren tiefere Teile die üppigen Lagenidenfaunen vom Badener Typus bergen.

An verschiedenen Profilen der Mistelbacher Scholle, wie in Grosskrut, Wilfersdorf, Siebenhirten u.a. konnte bestätigt werden, dass die ansonst für das oberste Torton charakteristischen Faunen der bei typischer Entwicklung grosswüchsigen *Rotalia beccarii* und Begleitern zufolge örtlicher Verhältnisse, wie sie z.B. durch die Nähe von Flussmündungen bedingt werden mögen, auch in tieferen Tortonhorizonten auftreten und sich den hier entwickelten reicheren marinen Vergesellschaftungen zwischenschalten. Meist aber kommt es zur Entwicklung von Faunen, an deren Zusammensetzung sich neben den Elementen der Rotalienvergesellschaftung auch noch verschiedene andere beteiligen, die nur in tieferen Tortonpartien zu finden sind. Auch in solchen Fällen lassen also die Mikrofaunen noch deutlich das Wesentliche in der Gesamtentwicklung des Tortons im Wiener Becken erkennen.

Wie die absolute, ist auch die relative Mächtigkeit der einzelnen Tortonzonen bedeutenden Schwankungen unterworfen, was vor allem auf das örtlich verschiedene Ausmass in den Absenkungsvorgängen zurückzuführen ist.

Sarmat und Pannon.—Das brackische Sarmat wurde bislang im Wiener Becken in einer Maximalmächtigkeit von 1100m. erbohrt. Die früher mit Hilfe von Mollusken durchgeführten Gliederungsversuche dieser Stufe waren zunächst mehr von lokaler Bedeutung, E. Veit (1943) gelang es, ein tieferes Sarmat mit vorzüglich Ervilien und dem Rissoenhorizont, von einer höheren Abteilung mit vorzüglich *Mactra* über das ganze Becken zu verfolgen. Durch den Verfasser wurde 1941 und 1943 eine Mikrogliederung der Stufe bekannt gegeben. Die einzelnen Zonen unterliegen in ihrer Zusammensetzung über weite Bezirke verhältnismässig geringen Abwandlungen, womit wohl ein gewisser Ausgleich der Fazies für den Gesamtraum zum Ausdruck gebracht wird.

Vielfach setzen die vorzüglich aus Tonmergeln und Sanden aufgebauten Sarmatprofile mit ärmeren Faunen mit *Rotalia beccarii*, *Elphidium*, *Chara*-Oogonien, etc. ein und es kommt in ihnen der brackisch-limnische Charakter zum Ausdruck, der dem tieferen Sarmat gebietsweise eigen ist. Darüber folgt in zahlreichen Profilen die sehr charakteristische Zone mit *Elphidium reginum* und Rissoen. Die genannte Foraminifere ist zwar nicht die häufigste, aber zufolge ihrer Grösse und Gestalt die auffälligste. Häufiger treten andere, auch grosswüchsige Elphidien auf, (*Elphidium* aff. *crispum*), ferner sind Ostracoden (*Cytheridea* aff. *mülleri*) neben den Rissoiden (*Mohrensternia* Arten) typisch. Es folgt eine Zone mit *Elphidium hauerinum-antoninum* als kennzeichnendste Art und das höhere Sarmat wird durch die Zone mit *Nonion granosum* eingenommen. Es gibt Faunen, die nahezu

ausschliesslich diese Art führen; andere enthalten auch *Rotalia beccarii*, Elphidien, Millioliden u.a. in bedeutendem Ausmasse.

Diese Gliederung wurde über das engere Wiener Becken hinaus durch V. Pokorny (1946) auch im Bohrgebiet Ivanka ENE. Pressburg, also bereits im Bereich des pannonischen Beckens, bestätigt. Bei schrittweiser Weiterverfolgung mögen sich daher aus den Mikrogliederungen durchaus brauchbare Mittel zur Parallelisierung der verschiedenen Jungtertiärbecken ergeben.

Weitere Beweise dafür hat für den pannonischen Anteil der Beckenfüllung H. Fahrion (1943) erbracht. Dieser Autor hat zunächst 1941 im Wiener Becken eine Gliederung der bisher mit 1250m. Maximalmächtigkeit nachgewiesenen brackisch-limnischen Serien des Pannons mit Hilfe von Mikrofaunen durchgeführt und die Beziehungen zu der von K. Friedl (1931) ausgearbeiteten Stratigraphie mit Hilfe von Mollusken hergestellt. Die Ostracoden liefern im Pannon das wichigste Mikroelement. Foraminiferenfaunen finden sich nur in den alleruntersten Metern. In der erstgenannten Arbeit werden deutliche Parallelen mit Mikroprofilen des Pannons im westlichen, südlichen und östlichen Teil des pannonischen Beckens nachgewiesen.

Das Pannon von Mähren wurde durch V. Pokorny (1944) mikropaläontologisch bearbeitet.

GRAZER BECKEN

Im Vergleich zu den im Wiener Becken durchgeführten mikropaläontologischen Untersuchungen sind die aus dem Grazer Becken vorliegenden Ergebnisse wesentlich geringer, was auf das kleinere Ausmass der bisherigen Bohrtätigkeit zurückzuführen ist. An richtigen Tiefbohrungen wurde im österreichischen Anteil bislang überhaupt nur die Bohrung Mureck 1 niedergebracht. Die Masse der Counterflush—Schurfbohrungen bewegte sich in den pannonischen Schichten, wie dies insbesondere für das in jüngster Zeit im burgenländischen Anteil durchgeführte Programm gilt.

Aus der Bohrung Mureck 1 aber liegen gesicherte paläontologische Ergebnisse nur aus einem beschränkten Profilbereich vor, die kurz erwähnt seien, da sie wahrscheinlich mehr als lokale Bedeutung haben.

Die noch im Jungtertiär bei 1188m. eingestellte Bohrung bewegte sich in den unteren 650m. in mergeligen Tonen, glimmerigen Sanden und Mürbsandsteinen sowie nach unten an Bedeutung zunehmenden Konglomeraten. Dies sind Süsswasserbildungen des Helvets, die ausser pflanzlichen Resten keine Fossilien führen. Darüber stellen sich marine Schichten, vorwiegend stark sandige Tonmergel ein, die partienweise eine reiche Mikrofauna lieferten. Davon ist der tiefere Teil, dies ist von 260 bis rund 500m. etwa, durch besonders reiche Faunen ausgezeichnet, in denen grosswüchsige Lageniden, wie *Robulus cultratus*, *Planularia cassis*, nebst zahlreichen weiteren Arten von *Robulus*, *Marginulina*, *Dentalina*, *Nodosaria*, *Vaginulina*, etc., vertreten sind. Dazu kommen noch mannigfaltige Begleitformen, wie sie für das tiefere Wasser kennzeichnend sind. In den oberhalb rund 260m. Tiefe gelegenen Schichten nimmt der Artenreichtum rapid ab und es stellen sich schliesslich Faunen ein, die nur noch *Rotalia beccarii*, *Elphidium* spp. und *Cibicides lobatulus* führen, womit aber möglicherweise auch schon das tiefste Sarmat erreicht ist. Wenn auch im einzelnen die stratigraphische Zuordnung der verschiedenen Mikrozonen von Mureck 1 noch offen gelassen werden muss, da eben aus dem Grazer Becken noch zu wenig Vergleichsmaterial vorliegt, so soll aber doch die allgemeine Tendenz in der Foraminiferenfolge festgehalten werden.

MOLASSEZONE

In der Molasse Oberösterreichs wurden die ersten umfangreichen Feldaufsammlungen für mikropaläontologische Untersuchungszwecke durchgeführt. V. Petters (1936) wertete sie zusammen mit den Profilen der Erdöl-und Erdgasbohrungen aus und konnte eine Mikrogliederung der oberösterreichischen Molasse aufstellen. Konnten auf Grund des lithologischen Befundes und der Molluskenfauna durch ungefähr gleichzeitige Arbeiten (R. Grill 1935) zwei Hauptschlierniveaus unterschieden werden und zwar ein oligozänes und ein miozänes, so gelang es V. Petters, diese zwei Niveaus auch mikrofaunistisch zu erfassen und weiterzuverfolgen und ferner wurde noch das Miozän

untergeteilt. Eine im Oligozän häufig auftretende *Cyclammina* wurde von R. J. Schubert (1903) wenig zutreffend als *C. gracilis* Grzyb. bestimmt. Über dem wahrscheinlich burdigalen Haller Schlier mit partienweise reichen marinen Foraminiferenfaunen liegt der *Robulus*-Schlier, für den vor allem *R. inornatus* kennzeichnend ist. H. Bürgl charakterisiert neuerdings im Hangenden des *Robulus*-Schlier einen Vöckla-Schlier mit einer *Cibicides*-Fauna und erachtet die Atzbacher Sande, die nach seinen Untersuchungen keine autochthonen Foraminiferen führen, als jüngstes Glied des unteren Mittelmiozäns (Helvet) dem auch bereits der *Robulus*-Schlier angehört.

Die kürzlich durch die Geologische Bundesanstalt durchgeführte Untersuchung einiger Profile durch die kohleführenden Süsswasserablagerungen Oberösterreichs, die ins Unterpliozän gestellt werden, deren tiefere Anteile aber auch noch ins Obermiozän hinunterreichen dürften, erbrachte keinen autochthonen Mikrofaunenbestand. Die partienweise gar nicht so selten auftretenden Foraminiferen sind eindeutig umgelagert und zwar in der Hauptsache aus dem Helvetikum, was von einem gewissen paläogeographischen Interesse ist.

Die oberösterreichische Schliermikrogliederung wurde weiterhin auch über das niederösterreichische Alpenvorland verfolgt (R. Grill 1941), womit auch der Beweis erbracht ist, dass sie von mehr als lokalem Interesse ist.

HELVETIKUM UND FLYSCH

Zufolge der Überschiebung der Molasse durch den Flysch und das Helvetikum sind im Grenzbereich beider bedeutende Falten und Schuppenstrukturen entwickelt, deren erdölgeologische Erfassung allein schon eine nähere Untersuchung auch des Flysches bzw. des Helvetikums notwendig machen. Darüber hinaus war aber in Österreich seit je das Augenmerk der Fachleute auf die Flyschzone im gesamten gerichtet, da sie doch in Galizien zahlreiche Ölfelder birgt. Vielleicht trat dieses Interesse durch die Erfolge im Bereich der jungtertiären Sedimente des Wiener Beckens zeitweilig etwas zurück. Da aber später bedeutende Erdöllager auch im Flyschuntergrund des Beckens erbohrt wurden, wurde eine moderne, regionale Analyse der gesamten Flyschzone unerlässlich. Zu diesem Zwecke wurde an der Geologischen Bundesanstalt durch G. Götzinger eine Arbeitsgemeinschaft eingerichtet, die sich unter dessen Führung mit dem vergleichenden Studium der Flyschablagerungen und des Helvetikums sowie dessen Analoga von der Salzach im Westen bis an die tschechoslowakische Landesgrenze beschäftigt. Die Untersuchungen knüpfen an die durch G. Götzinger bereits gut durchgearbeiteten Profile im Wienerwald einerseits an, anderseits an die aus Bayern vorliegenden Forschungsergebnisse.

Die mit den Feldaufnahmen Hand in Hand gehenden mikropaläontologischen Forschungen sind in vollem Fluss. Zunächst konnte manches zur Erfassung und Abgrenzung des Flysches gegen die Aufbrüche von Kreide-und Eozänschichten des Helvetikums, wie sie in Oberösterreich erstmals durch M. Richter und G. Müller-Deile (1940) teilweise bekannt wurden, beigetragen werden. Eine erste Bestandsaufnahme der Mikrofaunen des Helvetikums liegt vor und ebenso wurde für die Flyschablagerungen in dieser Hinsicht bereits viel vorgearbeitet.

Die in den oberösterreichischen Arbeitsgebieten von H. Becker, S. Prey und J. Schadler und unter deren Führung aufgesammelten Schlämmproben ergaben z.T. reiche Mikrofaunen. Die verschiedenen Stufen des Helvetikums sind zunächst durch das Vorherrschen der Kalkschaler paläontologisch klar geschieden von den vorzüglich Sandschaler führenden Flyschablagerungen. Die üppigen Faunen der oberkretazischen Leistmergel geben durch klare, zonenweise wechselnde Zusammensetzung wichtige Unterlagen für die Aufgliederung der Profile. Nebst den Globotruncanen, die mit *G. arca*, *G. linnaeana*, *G.* aff. *rosetta*, *G.* aff. *conica* u.a. auftreten, stellen insbesondere auch die Heteroheliciden wichtige Faunenelemente mit *Gümbelina* und *Pseudotextularia*. Diese treten an Häufigkeit in den Mergeln der bisher untersuchten mittleren Aufbrüche gegenüber den Bildungen der nördlicher gelegenen Streifen weitgehend zurück und kennzeichnen sie damit als älter als diese. Übereinstimmende Beobachtungen machte auch R. Noth (Aufnahmsbericht für 1947) im Bereich östlich der Krems.

Die sandreichen Mergel des Paläozäns wie sie durch F. Traub (1938) aus der Oichtenfurche bei Salzburg bekannt gemacht wurden, führen auch eine kennzeichnende grosswüchsige Mikrofauna mit

Bathysiphon, *Robulus*, *Lenticulina*, *Nodosaria*, etc. Die durch ihren Reichtum an wohlentwickelten Globigerinen gut charakterisierten, als Stockletten bezeichneten hellen Mergel des oberen Lutet konnten an einer Reihe weiterer Lokalitäten am Aussen–und Innenrand der oberösterreichischen Flyschzone mikropaläontologisch wieder erkannt werden.

Zahlreiche der vom Verfasser aus den österreichischen Flyschablagerungen gesammelten Proben führen Kleinforaminiferenfaunen, wenn diese auch nicht immer reich sind. Da an ihrer Zusammensetzung vielfach nur Sandschaler teilnehmen, weisen sie nicht selten einen anscheinend einförmigen Charakter auf. Tatsächlich aber ist dies nicht der Fall und es zeigen sich in der Zusammensetzung auch dieser Faunen gesetzmässige Veränderungen, wie vor allem auch an Bohrprofilen aus dem Flyschuntergrund des Wiener Beckens zu sehen ist.

Vorläufig liegen lokale Gliederungen der Flyschablagerungen mit Kleinforaminiferen vor, wie auch im mährischen Nachbargebiet M. Vašíček (1947) mit der Bearbeitung der Bohrungen von Hulken einen schönen Erfolg aufzuweisen hat. Den galizischen Flysch hat H. Hiltermann (1943) mit Kleinforaminiferen gegliedert.

Ein besonderes Augenmerk wurde der Untersuchung von Zügen der bunten Flyschtonschiefer zugewendet und insbesondere auch dort, wo sie, wie in Oberösterreich, in nahe räumliche Beziehung zu den Leistmergeln der helvetischen Streifenfenster treten. Es konnten dort bisher in keinem dieser Schiefer Foraminiferenfaunen gefunden werden, die auch nur entfernte Ähnlichkeit mit denen der bekanntlich ebenfalls bunten Leistmergel aufweisen würden. Die bunten Tonschiefer, die sich z.B. am Buchberg bei St. Georgen im Attergau der Oberkreide einschalten, führen eine Fauna mit *Rhabdammina abyssorum*, *Dendrophrya robusta*, *D. excelsa*, *Hormosina* aff. *ovulum*, *Ammodiscus hörnesi*, *Glomospira serpens*, *Trochamminoides irregularis*, *Haplophragmoides* u.a. Paläontologische Hinweise für ein Übergreifen der helvetischen Ablagerungsbedingungen auf den Flysch, wie dies vielfach behauptet wird, konnten also nicht gefunden werden, sondern es liegen im Gegenteil grundverschiedene Foraminiferenvergesellschaftungen vor, zwischen denen zumindest bislang keine Übergänge festzustellen waren.

ZUSAMMENFASSUNG

Unsere Kenntnis von den tertiären Beckensedimenten Österreichs wurde durch die Untersuchung der Mikrofaunen, an deren Zusammensetzung sich in erster Linie die Foraminiferen beteiligen, wesentlich erweitert. Sie geben die geologische Geschichte der einzelnen Beckenräume in viel feinerer Form wieder, als die vielfach nicht in dem gewünschten Ausmasse zur Verfügung stehenden Makrofaunen. Sie gestatten eine sichere Feingliederung der Stufen, was umso wichtiger ist, als deren Mächtigkeit partienweise 1000 m. überschreitet. Auch für die benachbarten Beckenräume sind die Untersuchungsergebnisse von Bedeutung. In den Flyschablagerungen sind die Kleinforaminiferen meist überhaupt der einzige faunistische Anhaltspunkt für eine stratigraphische Aufgliederung. Die reichen Foraminiferenfaunen der Kreide–und Eozänschichten des Helvetikums eignen sich ganz besonders für mikrostratigraphische Zwecke.

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DISCUSSION

In the discussion following the first group of papers, A. N. THOMAS (Iran) remarked that Mme. Gubler's work would help to solve other problems in the Tethys region. In Iran the foraminiferal fauna in the Upper Cretaceous succession is very similar to that described by Mme. Gubler. In this country also *Praealveolina* and *Ovalveolina* are both found to range above the Cenomanian into at least the Turonian and possibly into the Senonian.

J. CUVILLIER (France) stated that he was not opposed to the opinion of the survival of *Praealveolina* into deposits younger than Cenomanian, but in S.W. France all occurences of *Praealveolina* in such deposits which he had so far observed were redeposited in detrital material. These fossils were, in fact, probably not *in situ* but derived.

F. R. S. HENSON (Great Britain) remarked that Mme. Gubler's range chart for Cretaceous foraminifera in the south of France agreed very closely with observation not only in Iran but also in Iraq. He pointed out, however, that S. W. Tromp had recently published a paper in which he claimed that *Omphalocyclus* and other Cretaceous Orbitoids occurred as early as the Turonian in Turkey. However, later evidence made it seem most probable that the supposed Turonian Limestone of Tromp is, in fact, Maestrichtian in age.

STRATIGRAPHY OF THE CAENOZOIC OF THE EAST INDIES BASED ON FORAMINIFERA

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ABSTRACT

Owing to the autochthonous nature of the Caenozoic fauna of the East Indies, it is premature to use European names in their subdivisions. The " letter-classification " introduced by Van der Vlerk and Umbgrove (1927) has proved of practical value but is somewhat obsolete. A more detailed subdivision as proposed by Leupold and Van der Vlerk (1931) was based on the distribution of different species of foraminifera. As, however, nearly every investigator has his own opinion about species-characteristics this subdivision has more or less failed. It would be better, perhaps, to found more exact stratigraphy on morphogenetic research (Tan Sin Hok, Cosijn, Bannink). In the stratigraphical table here proposed eight divisions of the Caenozoic era are distinguished, each of them defined by different combination of 26 genera and subgenera. Only 2 characteristic species, both of them transition forms between two genera, are used. The most important assemblages to be mentioned in this abstract are:—

(*a*) *Flosculina—Discocylina—Assilina—Nummulites—Pellatispira.*

(*b*) *Discocyclina—Assilina—Nummulites—Pellatispira—Biplanispira.*

(*c*) reticulate *Nummulites* without the above-mentioned genera.

(*d*) reticulate *Nummulites* with *Lepidocyclina* (*Eulepidina* and *Lepidocyclina* s. str.)

(*e*) Lower part: *Austrotrillina—Miogypsina* (*Miogypsinoides* and *Miogypsina* s. str.)—*Lepidocyclina* (*Eulepidina*)—*Lepidocyclina* (*Nephrolepidina*) *isolepidinoides—Heterostegina borneënsis—Spiroclypeus.*

(*e*) Upper part: the same assemblage without *Heterostegina borneënsis* but with *Flosculinella* and *Lepidocyclina* (*Multilepidina* and *Trybliolepidina*).

(*f*) Lower part: the same assemblage as upper " f " but without *Eulepidina* and *Spiroclypeus* and with *Miogypsina* (*Conomiogypsinoides*)—*Cycloclypeus* (*Katacycloclypeus*) and other species of *Nephrolepidina.*

(*f*) Upper part: *Flosculinella—Alveolinella—Miogypsina* s. str.—*Nephrolepidina—Trybliolepidina* (abundant) and several subspecies of *Cycloclypeus.*

(*g*) Upper Caenozoic and Recent: *Alveolinella—Cycloclypeus* s. str.

OWING to the autochthonous nature of the Caenozoic fauna in the East Indies, it has not been possible to use the recognized European stratigraphical nomenclature. An extensive examination of Caenozoic molluscs had lead K. Martin (1914) to this conclusion. For elucidating the stratigraphy of this area the fauna, still living, was the only material available to work on. Martin used the same percentage method for the Caenozoic of the East Indies as did Lyell and Deshayes, in the first part of the nineteenth century, in subdividing the Caenozoic of Western Europe. He soon realized, however, that the percentages to be used here were very different from those used in Europe. Since the beginning of the Eocene there had been considerable fluctuations in climate in Europe, which was not the case in the East Indies. Consequently the changes in the East Indian fauna will have been smaller than in the European. This means that the percentages characteristic of the various epochs of the East Indies ought to be higher than those of the same geological age in Europe. How much higher they should be, still remains an unsolved problem. Thus it will at once be seen that a correlation of this autochthonous area with the Caenozoic of Europe and, by the same token, of America is not yet possible. There is therefore, every reason to use a special nomenclature for the stratigraphy of the Caenozoic of the East Indies.

In 1927 I (Van der Vlerk 1927) proposed the use of a simple letter-classification, which, however, was not founded on the molluscs but on the foraminifera. Seven divisions (Caenozoic " a-g ") were established, each of them defined by a different combination of genera of foraminifera. This subdivision was only based on a small collection of samples collected in stratigraphical order. In

subsequent investigations, however, it was found that this stratigraphical table provided a valuable basis of correlation throughout the East Indies region.

Some years later Leupold and Van der Vlerk (1931) published a more detailed subdivision based on the vertical distribution not only of genera, but also of subgenera and species. The epoch "a" was divided into two, the epochs "e" and "f" into five and three parts respectively. This subdivision was as yet not wholly satisfactory. In the first place it was founded largely on stratigraphical investigations which were executed exclusively in East Borneo; secondly, however carefully the work was carried out, the personal factor was bound to play too big a part in the determination of species. The vertical distribution shown in the table below keeps to a mean between those of 1927 and 1931. Only the epochs "e" and "f" are subdivided, not into five and three parts respectively, but each of them into a lower part and an upper part.

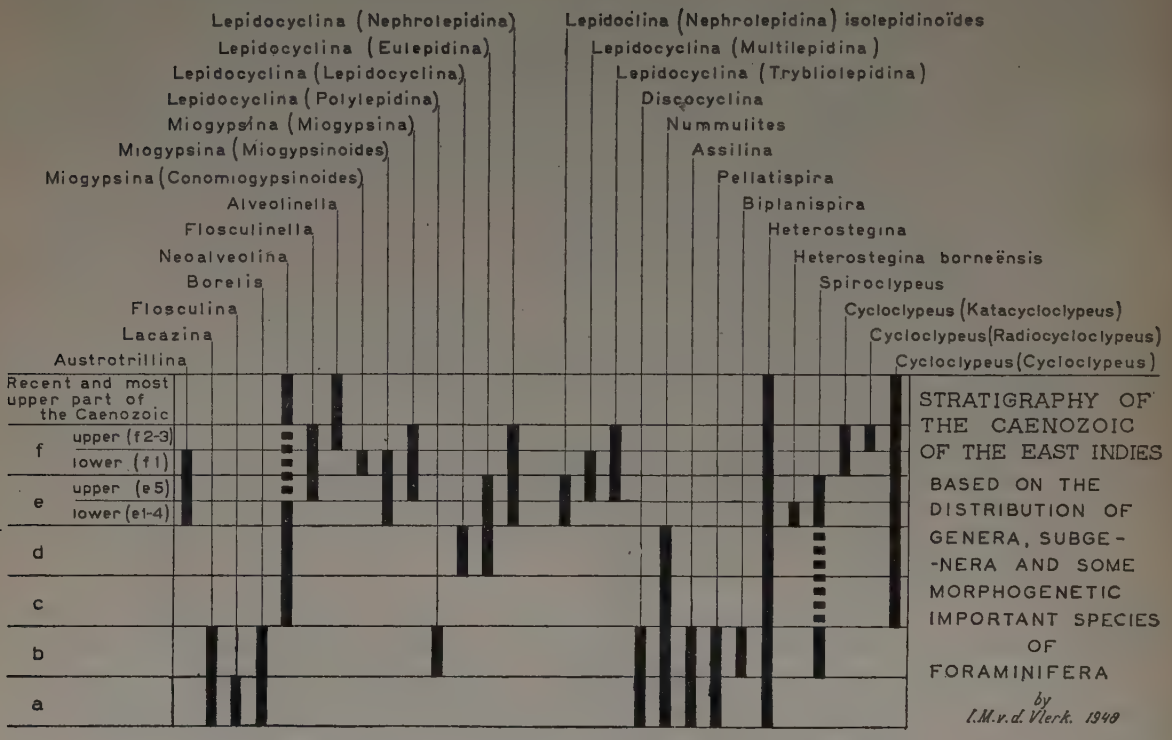

FIG. 1.—*Stratigraphy of the Caenozoic of the East Indies based on the distribution of Genera, Subgenera and some morphogenetic important species of Foraminifera.*

Lepidocyclina, *Assilina*, *Spiroclypeus* and *Cycloclypeus* are shown to have a wider stratigraphical distribution than was indicated in the older tables. Again the genus *Biplanispira*, since discovered, appears to be a good index-fossil for Caenozoic—"b". The main additions to the 1927 table, however, are shown in the distribution of the subgenera of *Miogypsina*, *Lepidocyclina* and *Cycloclypeus*. The subgeneric characteristics are sufficiently clear to avoid the tedium of specific identification which is not necessary for this stratigraphical work. *Lepidocyclina* (*Nephrolepidina*) *isolepidinoides* and *Heterostegina borneënsis* (Van der Vlerk 1929) are the only species added to the table. The first of these can be considered as a transition-form between the subgenera *Lepidocyclina* s. str. and *Nephrolepidina*. Its stratigraphical position is quite in harmony with this view. The second was originally considered to be a transition-form between *Heterostegina* and *Spiroclypeus*. In 1933 however *Spiroclypeus* was also found in Caenozoic—b (Tan 1937). Careful morphogenetic research on the genera *Heterostegina*

and *Spiroclypeus* will have to be made before the true value of the above mentioned species of *Heterostegina* can be judged. The stratigraphical importance of the two species may, however, be an indication of the direction in which research must proceed in order to compose a more exact subdivision.

When describing a new species of *Cycloclypeus* from E. Borneo (Van der Vlerk 1923), I pointed out that a clear evolution in the structure of the nepionic stage could be observed. This suggestion was worked out by Tan Sin Hok (1932) in an excellent monograph on this genus, a study in which the stratigraphical signification of the morphogenetic method of research was clearly demonstrated. Investigations by the same author (Tan 1936, 1937) on *Miogypsina* a, b, by Cosijn (1938, 1942) on *Lepidocyclina*, *Cycloclypeus* and *Globorotalia*, and by Bannink (1948) on *Operculina* have each in turn completely confirmed this opinion.

From the addition to our knowledge of the vertical distribution of genera and subgenera Tan (1936) claimed the non-autochthony of the Indo-Pacific region during the Eocene. This conclusion however, based on the presence of the subgenus *Polylepidina* in only one locality in East Borneo, seems to be premature. It is true, that *Spiroclypeus* is now also known from the Eocene of Borneo, but on the other hand the occurrence of this genus in the Eocene of Venezuela seems to be doubtful (Caudri 1944). The fact that genera and subgenera such as *Biplanispira*, *Austrotrillina*, *Flosculinella*, *Miogypsinoides*, *Trybliolepidina*, *Katacycloclypeus*, *Radiocycloclypeus* and a number of species of the other genera are restricted to the Far East is too important to doubt of the autochthony of this district.

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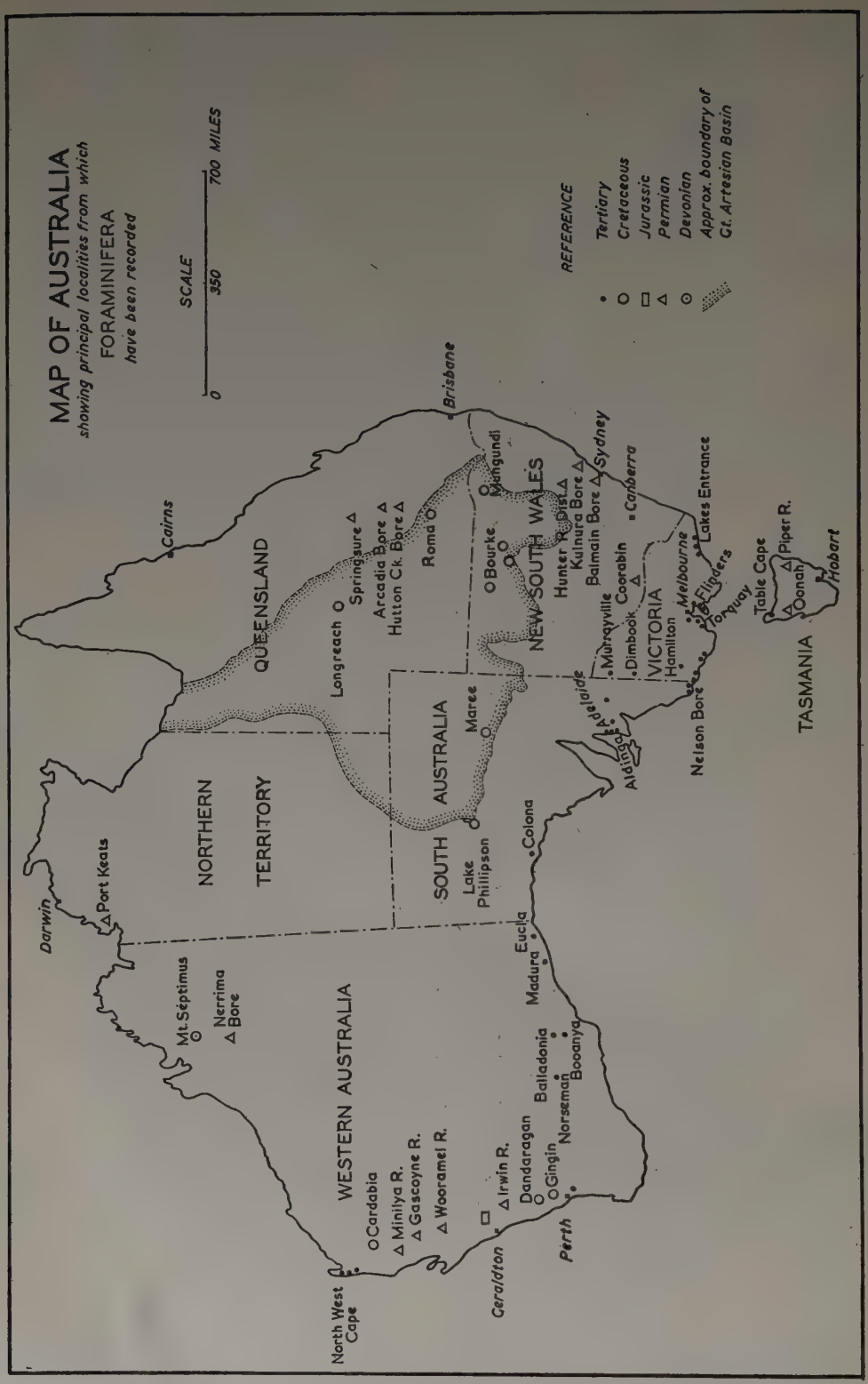

FIG. 1.—*Map of Australia showing principal localities from which Foraminifera have been recorded.*

FORAMINIFERA IN AUSTRALIAN STRATIGRAPHY

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Communicated by H. G. Raggatt (Australia)

I. INTRODUCTION

THE study of foraminifera in Australian stratigraphy has advanced considerably in the last twenty years because of the increased interest in the search for oil in this country. During this time extensive geological reconnaissance surveys and deep drilling operations have been and still are being carried out in certain parts of the continent. Interest has centred on the Tertiary, Lower Cretaceous and Permian deposits. Consequently the micropalaeontological content of these sediments has received special attention. Considerable information has also been derived from drilling operations in the search for water in the Tertiary sediments principally in Victoria, and in the Lower Cretaceous in the Great Artesian Basin, which occupies approximately 600,000 square miles of Central and Western Queensland, Northern New South Wales, north-eastern South Australia and south-eastern Northern Territory. Much detailed work remains to be done in Australia on the zoning of the various beds by means of the foraminifera, but the scarcity of workers in the field of micropalaeontology in this country makes the examination of these sediments lengthy and arduous.

There have been few workers on the foraminifera in Australia. One of the earliest was Charles Moore who in 1870 described some Mesozoic foraminifera from Wallumbilla near Roma in Queensland. Howchin in 1884 described Lower Cretaceous species from Hergott Springs (now Marree) in northern South Australia and later in 1894 and 1895 he recognized new species in the Permian rocks of Tasmania and Western Australia respectively. He published further papers chiefly on Tertiary foraminifera until 1938. Chapman was a prolific worker and his numerous publications on Australian foraminifera are well known. Parr has done much to advance the knowledge of this study in this country, and the author has published several papers on Permian, Cretaceous and Tertiary foraminifera and their relation to Australian stratigraphy. Glaessner has worked on Indo-Pacific stratigraphical problems.

Investigations by the author of the micropalaeontological content of sediments in Australia have covered a wide field and the accompanying map gives some idea of the areas studied. Nearly 200,000 feet of sub-surface samples have helped in determining useful zones. The Nelson Bore in Western Victoria reached the depth of 7,200 feet and the entire section was considered to be in Tertiary sediments of Middle Miocene age. The Arcadia Bore, in Queensland, was drilled to the depth of 6,036 feet and passed through 5,994 feet of Permian sediments which contained a zone of characteristic Permian foraminifera. The Kulnura Bore in New South Wales passed through a considerable thickness of Permian sediments containing foraminifera, before drilling ceased at 6,293 feet. Several bores occur in the Great Artesian Basin, one of the deepest, the Patchewarra Bore in northern South Australia, ceasing at 5,408 feet in Lower Cretaceous sediments with foraminifera. The most notable bore, however, is that drilled by the Australasian Petroleum Company at Kariava, Papua, which has just been completed at a depth of more than 12,000 feet in beds of Miocene age. The micropalaeontology was under the care of Dr. Glaessner.

II. DISTRIBUTION OF FORAMINIFERA

Foraminifera are extremely abundant in the Tertiary deposits of Australia. They occur in the area around Exmouth Gulf in Western Australia, around the southern coast of that State and across

the Nullarbor Plains into South Australia, in the vicinity of Adelaide and southern South Australia and at many localities in Victoria, east from the boundary with South Australia, along the south coast to the Gippsland Lakes. Extensive sub-surface deposits occur in north-western Victoria. Marine Tertiaries are not known in New South Wales and Queensland, but several outcrops occur in Tasmania.

Upper Cretaceous foraminifera are known only from Western Australia. However, Lower Cretaceous forms are found in many surface and sub-surface sections in the area referred to as the Great Artesian Basin. The only record up to the present of Jurassic foraminifera is in the sediments around Geraldton in Western Australia. These microfossils are of considerable importance in the Permian rocks of Queensland, New South Wales, Tasmania, Western Australia and Northern Territory. So far only a few foraminifera have been noted in the Devonian limestones of Western Australia.

III. NOTES ON SOME OF THE ASSEMBLAGES USED IN CORRELATION

A brief account of some of the more distinctive assemblages used in correlation will give some idea of the importance of foraminifera in Australian stratigraphy. Certain genera of the Orbitoids are useful for long range correlation of Tertiary horizons but unfortunately the important zonal forms of the Permian, the Fusulinids, are known only from one locality in Western Australia.

(*a*) *Tertiary*

The most detailed investigations so far carried out on the foraminifera in their relation to stratigraphy in Australia have been in the Tertiary. As a result of this work, the author suggests that the marine Tertiaries of Australia can be divided into two groups:

(1) The Indo-Pacific Group.

(2) The South-eastern Australia Group.

1.—*The Indo-Pacific Group.*—This Group contains genera and species of foraminifera which are of zonal importance in the oil-field deposits in Java, Sumatra, the Philippines and Japan; they form the basis of the " letter " classification instituted by Dutch palaeontologists for the Tertiary rocks of this region (van der Vlerk and Umbgrove, 1927). Limestones containing these species are found at localities extending from Exmouth Gulf in the Northwest Basin in Western Australia, south to localities on the Nullarbor Plains, which stretch from Norseman in Western Australia to Colona east of the head of the Great Australian Bight in south-western South Australia, then from the vicinity of Adelaide to north-western Victoria. Limestones containing similar foraminiferal species are found in various parts of Papua and New Guinea (Chapman, 1914, Crespin, 1938, 1939, 1948).

Zonal Eocene ("a-b" stage) foraminifera have been recorded only from the Northwest Basin in Western Australia, from Exmouth Gulf down to Cape Cuvier. The species include well known Indo-Pacific forms such as *Pellatispira inflata* Umbgrove, *P. rutteni* Umbgrove, *P. glabra* Umbgrove, *P. orbitoidea* (Provale), *Discocyclina dispansa* (Sowerby) var. *minor* Rutten (Chapman and Crespin, 1935). Small foraminifera from water bores at Perth are considered to be Eocene in age, but no larger forms are present to confirm this (Parr, 1938).

Oligocene ("c-d" stage) limestones in the Indo-Pacific region can be distinguished from those of Lower Miocene ("e") only by the presence of small reticulate Nummulites in the former, and the only record of such rocks in Australia is in the Northwest Basin of Western Australia, where large *Eulepidina* (*E. dilatata* Michelotti sp., *E. papuaensis* Chapman sp.), large *Cycloclypeus* (*C. eidae* Tan) are associated with small *Nummulites* (*N. intermedia* d'Archiac sp., Chapman, 1927).

Lower Miocene ("e" stage) rocks are also known only from the Northwest Basin, where Indo-Pacific zonal species such as *Eulepidina insulaenatalis* (Jones and Chapman), *E. papuaensis* (Chapman), *Spiroclypeus tidoenganensis* van der Vlerk and *Neoalveolina pygmaea* Hanzawa are recorded.

Zonal Indo-Pacific species of the Middle to Upper Miocene ("f" stage) are widely distributed in limestones in the Northwest Basin and occur as far south as the Nullarbor Plains, from Norseman, Booanya and Balladonia in Western Australia to Colona in south-eastern South Australia, in the

vicinity of Adelaide and in north-western Victoria. Four assemblages have been recognized, all representing warm, shallow water conditions:

(*a*) The lowest zone with *Lepidocyclina* (*Nephrolepidina*) and *Cycloclypeus*.

(*b*) *Nephrolepidina* with some species showing Trybliolepidine tendencies, *Flosculinella*, *Cycloclypeus* and *Miogypsina*.

(*c*) *Lepidocyclina* (chiefly *Trybliolepidina*), *Flosculinella*, *Marginopora* and numerous Miliolidae.

(*d*) Without *Lepidocyclina* but with *Austrotrillina*, *Flosculinella*, *Marginopora*, *Valvulina*, *Sorites*, *Peneroplis* and Miliolidae.

Assemblages (*a*) and (*b*) are correlated with "f_1-f_2" rocks of the Netherlands East Indies and assemblages (*c*) and (*d*) with "f_2-f_3". Assemblages (*a*), (*b*) and (*c*) are restricted to the Northwest Basin, but assemblage (*d*) is found in widely separated areas from the Northwest Basin to north-western Victoria.

Pliocene assemblages with Indo-Pacific affinities are not common in Australia, the only one of importance being present in the calcareous sandstones which underlie the Adelaide Plains and at certain outcrops south of Adelaide. The dominant forms in the assemblage are *Marginopora*, *Sorites*, *Peneroplis* and *Valvulina* which are warm shallow water forms such as frequent the seas adjacent to coral reefs. They are associated with Lower Pliocene species such as *Flintina intermedia* Howchin.

2.—*The Southeastern Australia Group.*—In Group 2, much of the zoning of the beds has to be done on assemblages of smaller species and long distance correlations are impossible. However, the Indo-Pacific influence still persists in an horizon high in the Middle Miocene of Victoria where species of *Lepidocyclina* (*Trybliolepidina* and *Cycloclypeus*) as well as *Austrotrillina howchini* occur, but where *Miogyosina* and *Flosculinella* are absent. The species of *Trybliolepidina* and *Cycloclypeus* are new, but at the same time show a close relationship with Indo-Pacific species (Crespin, 1941, 1942). Outcrops of *Lepidocyclina* limestone occur at Hamilton in southwestern Victoria, at Batesford west of Melbourne, at Flinders south-east of Melbourne and in Gippsland. The horizon is a persistent one in deep borings. *Austrotrillina howchini* (Schlumberger) was originally described from the *Lepidocyclina* limestone at Hamilton.

The stages, Anglesean, Janjukian, Balcombian, Mitchellian and Kalimnan in ascending sequence dominate Tertiary stratigraphy in Victoria. They contain representative assemblages of smaller species which can be recognized over a considerable area. Facies changes make it necessary to recognize other species, but in general, species described from the type sections form a basis for correlation of foraminiferal zones in Victoria, South Australia and Tasmania.

(*b*) *Cretaceous*

Upper Cretaceous foraminifera are known only from Western Australia where they occur in chalks, chalky limestones and glauconitic sands in the Northwest Basin and at Gin Gin and Dandaragan, north of Perth (Chapman, 1917; Raggatt, 1936; Crespin, 1938). Many of the species are similar to European ones and others to American forms. No attempt has yet been made to zone the beds by means of the foraminifera, but it is quite possible that the sequence from Cenomanian up to Campanian may be represented.

Lower Cretaceous foraminifera have a wide distribution. Up to the present the majority of species have been recorded from bores in the Great Artesian Basin and in the Northwest Basin (Howchin, 1884, 1895; Moore, 1870; Crespin, 1944, 1946). The assemblage is dominated by arenaceous genera such as *Haplophragmoides*, *Ammobaculites*, *Spiroplectammina*, *Trochammina* and *Verneuilina*, a feature which is apparently characteristic of Lower Cretaceous assemblages in America. All Australian species appear to be distinct. No zoning has been attempted yet, but the author has recently made a comprehensive collection of surface material from Roma, Queensland which is on the outer margin of the Basin, and hopes to be able to make a contribution to Lower Cretaceous stratigraphy at an early date.

(*c*) *Jurassic*

The main development of marine Jurassic sediments is in Western Australia in the vicinity of

Geraldton, 300 miles north of Perth. Chapman (1903) described some foraminifera from the area and during 1947, the author collected material for micro-examination from several localities north of Geraldton. A cursory examination has revealed some of Chapman's species. The mega-fossils suggest Middle Bajocian affinities.

(*d*) *Permian*

Foraminifera are widely distributed in the Permian rocks of Australia. They are found in the Springsure area in Queensland and are recorded from deep bores such as at Hutton Creek and Arcadia. In New South Wales, they occur at numerous localities in the Hunter River District, north of Sydney, and in deep borings such as the Kulnura Bore and in the Balmain Coal Shaft. They have also been found in localities in Tasmania. In Western Australia, in the Northwest Basin and in the Kimberley District further to the north, the foraminifera are of considerable importance in Permian stratigraphy and they have also been recorded from a bore at Port Keats, Northern Territory.

Howchin (1884, 1895) described Permian foraminifera from Tasmania and Western Australia and in 1905 in collaboration with Chapman described several new species from New South Wales. Crespin and Parr added further new species from New South Wales in 1940. In 1937 Chapman and Parr noted the only occurrence of Fusulines in Australia and recorded *Verbeekina* and *Neoschwagerina* from the Upper Ferruginous Series (of Wade) in the West Kimberley Area.

The author (1947) attempted to correlate the Permian beds of Australia by means of the foraminifera. She determined three assemblages. The outstanding assemblage is dominated by *Calcitornella stephensi* (Howchin), a form which is widely distributed in Australia and which has a limited vertical range. It forms a basis for correlation of an horizon in the Lower Marine Series of New South Wales with one in the Lower Bowen Series of Queensland, in the Lower Marine of Tasmania, and the Northwest Basin, Irwin River area and in the Kimberley area of Western Australia, and in the Port Keats Bore, Northern Territory.

Two other assemblages occur in the Upper Marine Series of New South Wales and afford a correlation with an horizon in the Middle Bowen Series of Queensland and in the Byro Beds and Wandagee Beds respectively of the Northwest Basin.

One assemblage contains *Hyperammonoides acicula* Parr, *Ammodiscus multicinctus* Crespin and Parr, *Digitina recurvata* Crespin and Parr, *Frondicularia woodwardi* Howchin. The second assemblage contains *Hyperamminoides acicula* Parr, *Ammodiscus multicinctus* Crespin and Parr (replaced by *Ammodiscus nitidus* Parr, in the Wandagee Beds), *Ammobaculites woolnoughi* Crespin and Parr and *Trochammina pulvillus* Crespin and Parr.

(*e*) *Devonian*

A few foraminifera have been discovered lately in limestones of Devonian age near Mount Septimus, in the Bonaparte Gulf Basin, Northern Australia. The genera included *Psammosphaera* and *Lagenammina*. As extensive investigations are being carried out in this region at the present time it is hoped that more definite forms will be discovered.

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THE STRATIGRAPHICAL VALUE OF FORAMINIFERA IN NEW ZEALAND (BASED ON CORRESPONDENCE AND LITERATURE FROM DR. H. J. FINLAY)

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ABSTRACT

Dr. H. J. Finlay has over the last eight years made a detailed stratigraphical study of foraminifera in New Zealand. The position has now been reached enabling foraminifera to be used with confidence as age-determiners from the uppermost Cretaceous to, and including, the Miocene, where mollusca have failed. Of the approximate number of 30 stages ranging from Upper Senonian to Recent, 14 have been established on microfaunal evidence. It has been found that there are very few foraminifera limited to one stage and that the zone indicator, in the confined sense, hardly exists. A system giving " multiple biochrons " was found by Finlay to be the best method of using foraminifera for zoning, and he employs certain " key species " recording the beginning and end-points of their vertical range. It is, at the same time, claimed that species *not* observed determine the age as much as, and more than, those actually seen. Smaller foraminifera have almost exclusively been used in this work. Neither *Nummulites* nor *Discocyclina* s.l. are found in New Zealand except for two rare occurrences of *Asterocyclina*. In the Aquitanian there are occurring together examples of *Eulepidina*, *Trybliolepidina* and *Miogypsina*. Both in the search for oil and for coal this method of using small foraminifera for stage determination has proved invaluable.

[The substance of this contribution is entirely the work of Dr. H. J. Finlay who has provided the material for its preparation and the present writer takes no credit for its contents.]

DR. H. J. FINLAY has come to the conclusion, after working firstly on the mollusca and then on the foraminifera, that the latter are on the whole more reliable in stratigraphical correlation and in age determinations in New Zealand. After some eight years work on the foraminifera he has arrived at a position where stratigraphy from the top of the Cretaceous to the Miocene inclusive depends almost wholly on foraminifera. Mollusca take second place in such work except in the Pliocene where foraminiferal changes are not marked and are suspected to be due largely to facies differences. From the Senonian to Recent there are nearly 30 stratigraphical divisions, 14 of which have been entirely separated on microfaunal evidence, while in many cases the safest identification of those already established is also by their microfauna.

The reliability of this information has stood the test of time; in Westland, for example, where many hundreds of samples have recently been collected from an area previously almost unknown stratigraphically, the age determinations given to the field-geologists from the evidence provided by the foraminifera have in no single case reversed the sequence of beds known to occur in the field, even in many cases of contiguous stages. A few of the Paleocene stages are known from good molluscan collections, but the gaps between them and the actual sequence of faunas could be determined only when the microfaunas were studied.

To do this work, it was at first necessary to collect as fully as possible from all known type localities and from all good exposures where the stratigraphical sequence appeared to be undisturbed. From samples thus collected complete microfauna had to be sorted out and mounted on slides for permanent record. Many of these samples contained 100-200 species. The complete collection of such slides runs into many hundreds from which the total faunal content and ecology can be studied.

Large charts and distribution columns were next drawn up for various important sections and these were then pieced together where they overlapped so that a long stratigraphical column was covered. After this had been done Dr. Finlay was in a position to sort out those species which had a

time value to their occurrence transgressing ecological boundaries from those which occurred only in particular lithological horizons, being merely facies indicators. This work took a long time and mistakes were made; for instance in the early days too much reliance was placed on certain forms which are now known to be only temperature or depth indicators.

It was found that very few species are limited to any one stage and therefore normal zoning as experienced with macrofossils hardly exists. A system akin to " multiple biochrons " was soon adopted and has yielded satisfactory results ever since. If the ranges in time of a sufficiently large number of species can be established then it is usually possible by noting the beginning and end points of them to determine the age of any given sample. Conversely assuming the accuracy both of determinations and of the knowledge of the ranges of these " key " species it is advantageous to use negative evidence as well as the positive just mentioned. It is surprising, in New Zealand, how well a combination of this positive and negative information can be utilized. Some nine or ten stages in the middle of the New Zealand Tertiary column, which were previously all included by many workers in the Miocene are now regularly and consistently separated by a combination of these methods, although there can be (if the facies remains suitable) a strong superficial similarity of background fauna, both macro- and micro-, in all of them. The New Zealand fossil whales and penguins and other vertebrates were, for example, all considered to be of Miocene age but the application of this intensive foraminiferal work shows beyond a shadow of doubt that they represent many different ages both in the Oligocene and Eocene.

Practically the whole of the work here described has been done by means of the smaller foraminifera. In spite of an extensive Eocene development there are no *Nummulites* nor *Discocyclina* in New Zealand, apart from two rare occurrences of *Astrocyclina* in the Lower and Upper Eocene respectively. (Another peculiarity of the same kind is the very rare occurrence of *Globotruncana* in the Upper Cretaceous.) Orbitoids do not reappear until the Altonian stage is reached, probably for climatic reasons. Here *Eulepidina*, *Trybliolepidina* and *Miogypsina* all appear together. The first of these being represented in the upper limit of the Aquitanian of the Indo-Pacific area and the latter two in the lower limit, compelled New Zealand geologists to regard the Altonian as Aquitanian using it, in common with most Indo-Pacific workers, as the base of the Miocene. Orbitoids continue sparingly together with certain species of *Cycloclypeus* for three more stages but are not found after the Waiauan stage, which is believed to be Tortonian. The Awamoan and Hutchinsonian stages were completely confused in literature with these four Miocene stages until the microfauna was carefully studied, and this confusion would undoubtedly still exist if it had not been for this. Discrepancies in the mollusc and brachiopod fauna were then able to be explained.

From the economic aspect the oil companies in New Zealand have relied very largely on the microfauna for their correlation, although no oil has as yet been found. In the South Island, coal survey work has made more successful use of this tool, and the discovery of at least one new coalfield can be placed to the credit of geologists who used and made deductions from micropalaeontological work.

Finally, on the systematic side, a change from normal procedure has resulted from the methods already described in treating the foraminifera. Because of our main reliance on them and the necessity for using the " multiple biochron " method, the importance of " key " or " index " species was early recognized, and when description of new forms inevitably followed their discovery and use, Dr. Finlay decided not to describe total faunas from particular localities as has been the general practice, but to concentrate first on those specimens more likely to be of immediate use in a new field of exploration.

Thus began the series of papers by H. J. Finlay entitled " New Zealand Foraminifera : Key species in Stratigraphy " (see References below). Further papers were published, in two instances in collaboration with J. Marwick on the division of the Upper Cretaceous and Tertiary, and a third by Finlay only on a proposed correlation from the Danian to the Pleistocene, between New Zealand and other Pacific areas. Not all those species of foraminifera first described have since proved as useful as was originally hoped, and many more which exist at present only as manuscript names are

now in regular use as indicators, but this is inevitable when experiment by trial and error is proceeding at the same time as stratigraphical decipherment and as discovery of new sections in new areas continues.

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FORAMINIFERA AND THE STRATIGRAPHY OF THE INDO-AFGHAN BORDER

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ABSTRACT

While serving on the Indo-Afghan border nearly thirty years ago, the author tried to elucidate the stratigraphy of the highly fossiliferous Cretaceo-Eocene beds of that region, their exact ages and correlations being then still undefined. Studying, for this purpose, the distributions of fossils of all kinds found in those beds, the author was impressed by their very unequal values to this end. Some forms—like pelecypods—gave little help, while ammonites, corals and echinoids often afforded decisive evidence for the zoning of exposures; but much the most generally and practically useful forms were the foraminifera.

This was due to the relatively wide distribution, small size, and vast numbers of these protozoa. While not more individually decisive than ammonites or echinoids, foraminifera were much more likely to appear, and appear intact, to elucidate faulted and folded structures, showing only fragments of beds in that mountainous region. Indeed, several foraminiferal species might be identified in a single hand specimen, thus clearly establishing its zonal position.

For these reasons, the author's detailed mapping of the Kohat District, and correlations of particular horizons over an area extending from western Persia to eastern Thibet, were eventually based, in the main, on foraminiferal evidence.

WHILE serving on the Indo-Afghan border, nearly thirty years ago, the author became interested in the geology of the Kohat District, about which much less was then known than about the geology of other areas. It had, indeed, been established that the local sequence included Jurassic, Cretaceous and Eocene beds, with fluviatile deposits of later date; but hardly any study had been made of their contained fossils, so that it was still impossible exactly to correlate any parts of the Kohat succession either with Himalayan beds to the east, or with Sind and Baluchistan ones to the south, on which Indian stratigraphic terminology was—and still is—so largely based.

The author was fortunate in finding straight sections in the Shekhan Nullah near Kohat itself (33° 35′ N. : 71° 28′ E.), where the Tertiary succession could be seen, and on the Samana Range near Fort Lockhart (33° 35′ N. : 70° 55′ E.) which showed the Mesozoic sequence; while sections near Thal (33° 21′ N. : 70° 34′ E.) overlapped the Kohat and Samana ones, linking the whole together.

Having thus obtained evidence of the nature of the sequence, the author divided the same into " beds " to which distinctive numbers were given, and proceeded to make separate collections of the fossils contained in each of these beds.

For the identifications of the fossils, and information as to their stratigraphic values, he at first relied mainly on the Palaeontologist of the Indian Geological Survey Staff at Calcutta, the late Dr. J. Coggin Brown, to whom his main collections were sent. But forms which could not be identified in Calcutta were also sent to specialists in Britain and elsewhere—the ammonites to Dr. L. F. Spath, other molluscs to Dr. L. R. Cox, brachiopods to Miss H. Muir-Wood, corals to the late Prof. J. W. Gregory, echinoids to Dr. Ethel Currie, and foraminifera to the late Prof. H. Douvillé, the late Mr. R. Bullen Newton and others, for opinions, and possible descriptions of the same.*

With the help of these workers, considerable advance was made in determining the limits between the formations; and even in identifying stages within the formations (or geological series) with known stages in other parts of northern India. For this purpose, the ammonites, echinoids and foraminifera

* For published work on these by Spath, Cox, Muir-Wood, Gregory and Currie, see *Palaeont. Indica*, N.S., vol. xv, 1930.

proved to be the most useful forms; while the corals, etc., often helped to strengthen the case for particular stratigraphic correlations. The author's first papers on the geology of Kohat (Davies 1925), and on the correlations of Mr. Pinfold's Chharat series (Davies 1926, 1927), were largely based on these determinations by other workers; although he soon began personally to study some of the more important echinoid and foraminiferal types.

Here he was greatly helped by the papers on Ranikot and later foraminifera published by Dr. W. L. F. Nuttall (1925, 1926), whose accurate descriptions and good illustrations of foraminifera from the type areas to the south (Sind and Baluchistan) were invaluable for identifying corresponding forms found in the Kohat District, and so made it possible to prove the existence of Ranikot (Paleocene) beds at Thal (Davies 1927a), five hundred miles north of the region to which they had long been supposed to be confined.

Indeed, it soon became clear that foraminifera, owing to their small size, vast numbers and general ubiquity, were much the most useful forms, for stratigraphic purposes, wherever they appeared (which was mainly in the late Cretaceous and early Tertiary deposits). Valuable as echinoids also were at those levels—being quite as decisive as foraminifera where they were found (Davies 1943)—their relatively large size, small numbers, and tendency to appear only in certain parts even of the same strike, made them much less constantly serviceable when dealing with small and disconnected outcrops.

What is more: in that mountainous region, there were many cases of crushed, folded and faulted beds, in which the larger fossils—if found at all—were apt to be only fragmentary. In such cases, the foraminifera alone appeared intact, and capable of assured identification; while several species might be represented even in a single hand specimen, often thus enabling the smallest part of a bed to be identified. So, for detailed mapping of the more disturbed portions of that area, and elucidation of the structures found in the same, it soon became clear that one was mainly—if not entirely—dependent on the evidence of the contained foraminifera.

Again: having identified certain important stages, it became possible to increase our knowledge of their characteristic faunas, and hence of their distribution. Thus the known Ranikot foraminifera were very few, even when Nuttall's early papers appeared; but once the northern (Kohat District) Ranikot exposures had been identified beyond doubt, it was easy to increase our knowledge of their contents by further examination. As a result, the list of known Ranikot foraminifera presently compared well with the lists of known foraminifera from later levels (Laki and Khirthar, or Lower and Middle Eocene); and Ranikot exposures have consequently been since traced, on the basis of their foraminiferal contents, as far as western Persia (Shamshir-i-Quli, 33° 30′ N.: 47° 10′ E.) on the one hand (Davies 1938), and eastern Thibet (Kampa Dzong, 28° 16′ N.: 88° 36′ E.) on the other (Davies 1937).

It was also owing, in the main, to the more detailed information afforded by the foraminifera, that palaeogeographical maps could be prepared, with fair assurance, showing the changing distributions of land and sea over the Indo-Afghan region during late Cretaceous and early Tertiary times (Davies 1940). Among other things, this led to the more accurate dating of the first emergence of the North-Western portion of the Himalayan axis, and the tracing of the early history of the great rivers which owed their origin to the manner of that emergence (Davies 1940a).

As illustrating the value of foraminifera for stratigraphic purposes, it may here be recalled that experienced geologists, who were not micropalaeontologists, concluded—on lithological and other grounds—that Ranikot beds were only doubtfully present in Waziristan (on the Indo-Afghan border) while Laki beds were certainly present (Heron 1937). Yet this is the direct reverse of the case; for the Ranikot is undoubtedly present, while the Laki is totally absent (Davies 1938a, 1938b). Lithological resemblances are deceptive, since closely similar lithological deposits appear at very different levels in the Cretaceo-Tertiary succession of N.W. India. Indeed, the constant appearance, in Waziristan, of beds full of Upper Ranikot (late Paleocene) foraminifera, directly superimposed by beds full of Middle Khirthar (late Middle Eocene) forms, shows that what the author calls a "Waziristan ridge"

must have extended southwards from the Pamir knot during Lower Eocene and early Middle Eocene times; and this in turn helps to explain the cutting-off and desiccation of marine waters in the Kohat-Potwar basin, which led to the formation of the great Salt deposits of the Bahadur Khel region (33° 10′ N.: 70° 50′ E.) and further east (Davies 1944, 1945).

It is also significant that although so able and experienced a worker as G. de P. Cotter, of the Indian Geological Survey, thought that the Ranikot sea never reached the Punjab Salt Range (Cotter 1933), and even Mr. E. R. Gee could not, after six seasons' work on that Range, say whether the Tertiary sequence there began with Ranikot or early Laki beds (Fermor 1935), the author was able, immediately on receipt of collections sent him from that sequence by Mr. E. S. Pinfold of the Attock Oil Company, to say that they were packed with typical Ranikot foraminifera (Davies 1935). And after further combined work on the Salt Range sequence, Mr. Pinfold and he were able to establish the existence of three successive and quite distinct Ranikot zones on that Range, followed by three successive and quite distinct Laki ones (Davies and Pinfold 1937).

After repeated experiences of this kind, the author—who began work on the stratigraphy of the Indo-Afghan border without prejudice in favour of any particular group of fossils—came to regard its fossil foraminifera as affording much the most constant and valuable information for elucidating at least the Cretaceo-Eocene stratigraphy of that region.

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DISCUSSION

F. R. S. Henson (Great Britain) supplemented L. M. Davies' remarks on the occurrence of a Ranikot fauna as far west as S.W. Persia; he also observed that Ranikot foraminifera have now been found over a wide area along the Arabian shore of the Persian Gulf in deep wells.

C. A. Flemming (New Zealand) pointed out in connection with C. D. Ovey's paper on H. J. Finlay's work in New Zealand, that while foraminifera were indeed of the greatest value in stratigraphy macrofossils were sometimes still of some considerable import. He asked I. M. van der Vlerk why the smaller foraminifera were not more widely used in the East Indies, and sought further information on the autochthonous nature of the East Indies microfauna. He suggested that the use of local stage names, in place of the " letter-classification " which was difficult for outside workers to grasp, should be recommended.

Miss J. Everest (U.S.A.) pointed out that L. W. Le Roy who had worked for many years in the Netherlands East Indies had published at least three papers on the smaller foraminifera of that area in the publications of the Colorado School of Mines.

I. M. van der Vlerk, in reply, said that in preparing the table used to illustrate his paper he had listed the larger foraminifera only, being aware that specialists employed by the Oil Companies in that area knew more about the small forms than he, and, with the exception of those publications of L. W. Le Roy, nothing had been printed on the subject. As regards the autochthony of the fauna he pointed to the fact that genera and subgenera such as *Biplanispira*, *Austrotrillina*, *Flosculinella*, *Miogypsinoides*, *Trybliolepidina*, *Radiocycloclypeus* and a number of other species are restricted to the Far East. Such evidence is too significant to doubt the autochthony of the Indo-Pacific fauna. Finally, van der Vlerk said that he preferred to use the " letter-classification " to indicate the different epochs because the localities were both difficult to pronounce and to remember.

J. Cuvillier (France) added that *Lacazina* together with *Alveolina* had been found in sediments of Lower and Middle Eocene age in the Suez region of Egypt.

A. N. Thomas (Iran) mentioned that the Dunghan Limestone at first assigned to Laki age included at least three distinct formations in the Bolan area. He remarked that the Salt Range salt had been ascribed to the Tertiary by B. Sahni but similar spores had been found in the " pseudomorph bed " of undoubted Cambrian age.

L. M. Davies (Great Britain) in reply stated that the name " Dunghan Limestone " had been given by Oldham to the Cretaceous formation which the latter found on the Dunghan Range. He showed that the beds referred to were full of typical Cretaceous macrofossils. Davies contended that it did not seem right to apply this name to limestones of Laki age found in the Bolan region and suggested that the expression " Bolan Limestone " would be more suitable for the latter. Collections from the Dunghan Range, since sent to Davies by the Burmah Oil Company, showed that a great thickness of late Cretaceous beds (rich in such foraminifera as *Omphalocyclus macropora*, *Orbitoides media*, *Siderolites calcitrapoides*, etc.,) were there succeeded by a much smaller thickness of typical Ranikot beds, while the Laki is only represented by a very thin sediment above. He concluded that these last were certainly not the principal features of the local stratigraphy.

B. F. Howell (U.S.A.) asked whether spores of Tertiary type had been found in the *same* beds with Cambrian fossils (in the salt pseudomorph beds). He mentioned that Darrah had found spores in the Swedish Kolm.

A. N. Thomas replied that, as regards the Salt Range, beds containing Cambrian *Palaeobolus* occurred *above* the spore beds.

L. R. Wilson (U.S.A.) said that the spores reported by Darrah as Cambrian in age in Sweden have been assigned by Jeffries to contamination. He added that he himself had examined photomicrographs of B. Sahni's fossil Salt Range spores. From this examination he considered that they could be compared very closely with Eocene spores and pollen of America: many species in fact, may even be the same.

UN FORAMINIFÈRE NOUVEAU DU LUTÉTIEN SUPÉRIEUR D'AQUITAINE

Par J. CUVILLIER

France

ABSTRACT

Ce fossile n'est connu que par une section transversale, en plaque mince, dans un calcaire à Orthophragmines provenant de Guiche (Basses-Pyrénées); c'est une forme en cône très plat, largement ouvert, à test calcaire, rappelant assez le galbe de *Dictyoconoides* sans présenter les caractères structuraux internes de ce dernier genre ni la différenciation particulière de sa muraille externe.

DISCUSSION

In reply to the author's request for ideas concerning the identity and taxonomy of his new Lutetian genus, L. M. Davies (Great Britain) suggested that the nearest affinity was with *Dictyoconus*. In the absence of further discussion the Chairman closed the meeting.

3. PALAEONTOLOGICAL NOMENCLATURE

The third open meeting of the Union was held on August 31st with Vice-President W. J. JONGMANS (Netherlands) in the chair. Two papers were communicated, each followed by discussions.

REFORMS IN ZOOLOGICAL NOMENCLATURE ADOPTED BY THE THIRTEENTH INTERNATIONAL CONGRESS OF ZOOLOGY IN PARIS, JULY 1948

By FRANCIS HEMMING*

IN order to understand the important advances in zoological (including palaeozoological) nomenclature achieved during the recent Zoological Congress in Paris, it is necessary to recall something of the past history of the subject and to describe the situation as it existed at the opening of that Congress.

Zoological nomenclature, as is well known, dates from the Tenth Edition of Linnaeus's *Systema Naturae* which was published in 1758, but Linnaeus himself never propounded a code of rules for the naming of animals, apparently considering that the rules which he had laid down for botanical nomenclature in his *Philosophia botanica* of 1751 should be sufficient. The most important of these rules was the Law of Priority, which prescribed that, other things being equal, each species was to be known by the first name published for it with a description or indication of its characters.

The nineteenth century witnessed an enormous increase in the number of known species and in order to fit these species into the general scheme of classification, zoologists were forced to establish many new genera. Serious difficulties at once arose: the lack of any central recording system led to a multiplication of synonyms and homonyms, and the lack of a code of nomenclature led to wide divergencies in the manner in which the Law of Priority was applied, particularly as regards the delimitation of genera. Various attempts were made to establish a set of rules for applying the Linnaean System, but so long as these remained on a purely national basis, they failed to win any general acceptance. The First International Congress of Geology held at Genoa in 1881 was notable as the first occasion on which the idea of trying to establish an agreed international code of zoological and palaeozoological nomenclature was seriously advanced. Nothing was actually attempted in this matter until the First International Congress of Zoology met in Paris in 1889, but this first attempt to secure an internationally agreed code of nomenclature failed on account of the extreme individualism of zoologists and the wide divergencies of practice which had grown up during the 130 years that had elapsed since the introduction of the Linnaean System. It was evident, however, that there was a general desire for a settlement, and, realizing this, the Third International Congress at Leiden in 1895 continued its efforts to devise an agreed code and established for this purpose an International Commission on Zoological Nomenclature with the express duty of drawing up proposals likely to win general acceptance. It was not, however, until the Congress of Berlin in 1901 that agreement was finally reached and the present code—the *Règles Internationales de la Nomenclature Zoologique*—was adopted. The acceptance of this code was a substantial achievement, but, in order to secure it,

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compromises had to be accepted which seriously weakened its effectiveness. These compromises consisted in part of the omission of provisions on questions on which no agreement could be reached, and in part of the adoption of deliberate ambiguities in drafting, which made it possible to interpret certain provisions in diametrically opposed ways according to the preferences of individual zoologists.

It is not surprising therefore, that serious difficulties soon began to arise. The ambiguities in drafting made it impossible to secure uniformity of practice, which was one of the principal objects of the *Règles*, and the rigid retroactive application of the Law of Priority, far from stabilizing existing practice, led to the digging-up of long-forgotten names and a consequent widespread disturbance of nomenclature. It was in an attempt to mitigate the unfortunate effects of the ambiguities of the *Règles* that the Congress in 1907 granted to the Commission judicial powers to interpret the code, powers which it exercised by rendering *Opinions* both on the status of individual names and works and on the interpretation of particular provisions of the *Règles*. While this helped to secure some uniformity of practice, it inevitably had the effect of uncovering the ambiguities and inconsistencies inherent in the code itself. A fresh outburst of controversy led to the grant to the Commission by the Congress at Monaco in 1913 of plenary powers to suspend the *Règles* where they were satisfied that greater confusion than uniformity would otherwise result. At the same time the Commission was instructed to draw up an " Official List of Generic Names in Zoology." Two classes of generic names were placed on this List: first, those generic names which had been validated, or of which the types had been fixed by the Commission under its plenary powers, and which were therefore, " nomina conservanda " in the literal sense; and, second, names of important genera which were thought to be valid under the *Règles*, but which, if later bibliographical research showed them to be invalid under the *Règles*, possessed no special status and had therefore, to be removed from the List.

Such beneficial effects as might have been looked for from the innovations at Monaco were postponed by the outbreak of the First World War which brought the activity of the International Commission to a standstill, and very nearly led to the collapse of the Commission itself. The inter-war period was one of general defeatism, the number of zoologists who had formed rigid views on nomenclature prior to the adoption of the *Règles* in 1901 being still too great to permit any agreed reform of the code, while a widespread sense of irritation at the inadequacies of the existing rules was beginning to manifest itself among the younger generation.

The outbreak of the Second World War in 1939 brought the work of the Commission once more to a temporary halt, but in 1943 the Secretariat, which had in 1936 moved from Washington to London, was able to resume activity on a limited front. *Opinions* were published on all the cases which had been decided at the last meeting of the Commission in Lisbon in 1935, and a beginning was made with the re-issue of the earlier *Opinions* which had become out of print and were practically unobtainable, particularly in Europe. At the same time the Commission started to publish its own journal, the *Bulletin of Zoological Nomenclature* containing all the applications then before the Commission, and comments upon them. Partly, no doubt, as a result of these activities, the volume of correspondence of the Commission began to increase rapidly, showing a growing interest among zoologists in the international regulation of nomenclatorial questions, and at the same time a growing desire to see fundamental reforms in the code itself. It became evident to the Executive Committee of the Commission that there would be a general desire for amendment of the *Règles* at the first post-war meeting of the International Congress of Zoology which was due to be held in Paris in 1948. They felt, however, that it was extremely important that any move in this direction should be one that commanded the general support of working zoologists in all parts of the world, and, in particular, that care should be taken that no undue weight should be given, in case of divergencies of view, to the wishes of the particular local majority of zoologists attending the Congress. The Commission were especially pleased therefore when, towards the end of 1947, the Secretary received an invitation from the Smithsonian Institution to visit the United States for the purpose of holding discussions with American zoologists and palaeontologists on nomenclatorial matters and, in particular, about the agenda of the forthcoming Paris meeting. Comprehensive discussions were held with zoologists and palaeontologists in the Smithsonian

Institution, in the Chicago Natural History Museum, in the American Museum of Natural History in New York, with zoologists and palaeontologists attending the Christmas meetings of the American Association for the Advancement of Science in Chicago and palaeontologists attending the annual meeting of the Geological and Paleontological Societies of America in Ottawa. These discussions provided an up-to-date overall picture of the current views and wishes of the general body of zoologists and palaeontologists in the United States and Canada which was of the greatest value in preparing the agenda for the Paris meetings, where it was expected that zoologists from the New World might be somewhat under-represented as compared with those from Europe.

The Commission began its meetings on the day after the opening of the Paris Congress, and introduced the important innovation of throwing all their meetings open to all members of the Congress. This gave the general body of zoologists present an opportunity of seeing how the Commission works and of making valuable contributions to their discussions.

The Secretary had prepared and circulated to members and alternate members of the Commission present in Paris a series of papers giving details of three groups of proposals: (1) for the reform of the constitution and procedure of the Commission, put forward by the Executive Committee, (2) for various additions and amendments to the *Règles Internationales*, received from individual zoologists, from groups of zoologists or submitted by the Secretary as constituting what seemed to him the most generally acceptable compromise between divergent views, and (3) for dealing with a number of individual cases which had been submitted to the Commission and were still outstanding. These papers will shortly be published in the *Bulletin of Zoological Nomenclature*.

The proposals as finally agreed after discussion both in the Commission and in the Section on Nomenclature were approved unanimously both by the Section and by the Congress itself at its final plenary session.

The first group of proposals concerning the constitution of the Commission were designed to secure a more representative and international character for the Commission. It was agreed that the Commission should no longer have a fixed membership of 18, but that in future this should constitute a minimum, there being henceforth no upper limit to the number of members. Under the new system workers from any country in which a considerable body of zoological or palaeontological work is being carried out will be able to apply for direct representation on the Commission, and the Commission itself will be able to call to its membership leading specialists in particular fields irrespective of country.

Extensive changes in the procedure of the Commission were introduced with a view to speeding up the rate at which decisions could be reached and promulgated on questions submitted to it. The most important single reform is the abolition of the *Liberum Veto* imposed by the Commission on itself in a spirit of undue conservatism in the year 1910, under which a single member of the Commission could prevent a decision being reached by the Commission either on a proposed amendment of the *Règles* or in the use of the plenary powers for conserving a name in common use but technically defective.

The proposals for the reform of the *Règles Internationales* were of five main kinds: Firstly, improvements in drafting designed to remove ambiguities and inconsistencies in the present text. Secondly, the incorporation in the *Règles* of all the decisions of principle contained in the past *Opinions* and the cancellation of those *Opinions* for interpretative purposes. At the same time, for the convenience of zoologists, it was agreed that all the decisions on individual works and names contained in these *Opinions* should be recorded in special Schedules to be attached to the *Règles*, so that reference to old *Opinions* would no longer be necessary. Henceforth all decisions on matters of principle taken between sessions of the Congress are to be issued as *Declarations*, containing proposals for incorporation in the *Règles* at the next Congress; and all decisions on individual works or names will be issued first as *Opinions*, and inserted in the appropriate Schedule at the next Congress.

Thirdly, in certain cases, provisions of the *Règles* were changed where they were found to conflict with the wishes or practice of the general body of zoologists and palaeontologists. For example, as a result of a widely-based petition to the Commission, it was agreed to amend Article 25 (as interpreted in *Opinion* 1) to admit as available the names of genera published with no description but containing

one or more recognizable nominal species, as this was found to accord with the wishes and practice of the majority of workers.

Fourthly, amendments were introduced in some existing provisions where the meaning was not clear or where they were not sufficiently comprehensive to cover all the cases that might arise. In particular, a comprehensive revision was undertaken of Articles 35 and 36 dealing with specific homonyms, the ambiguities and defects in which had given rise to many divergencies of interpretation and practice in the past.

Finally, in some cases it was agreed to introduce new provisions to deal with important matters not covered at all in the present *Règles*. One such case was the status of names given to infra-subspecific forms, a question which had been raised at the last Congress at Lisbon, but which had then been referred to the Secretary for further study and report.

The Commission adopted a similar procedure to this on a number of further questions which were raised at the Paris Congress but which it was felt had not been sufficiently studied or on which there was not yet enough community of views to secure an agreed solution at the present stage. These questions included the provisions regarding the emendation of names, the formation and regulation of names of families and higher categories and the status of neotypes. On all these matters the Secretary was instructed to consult with specialists and to present a report and proposals to the next Congress to be held in Copenhagen in 1953. Any observations or suggestions on any of these matters would therefore be warmly welcomed by the Commission.

On any questions on which it was decided to introduce substantially new or more rigorous provisions, it was found desirable to adopt a less severe standard to be applied to names given in the past than to those to be given in the future, after the adoption of the new provisions. Moreover, in order to avoid the inadvertant invalidation of names on purely technical or " ritualistic " grounds, a distinction was drawn between the ideal procedure, which was to be laid down in the form of " *Recommandations*," and the minimum necessary procedure which alone was to be included in the mandatory provisions.

Two important steps were taken with a view to meeting the manifest desire of zoologists in general for greater stability of established nomenclature. The first concerned the status of certain generic names which had been placed on the " Official List " not under the plenary powers, but in the belief that they were nomenclatorially available and that their types had been correctly determined. In some cases entries of names of this class had later been found to be erroneous and the names in question had thereupon become liable to be removed from the " Official List." It was decided that in future, no name once placed on the " Official List " should be removed therefrom unless, the matter having been submitted to them, the Commission should so direct. By this measure, a far-reaching method for securing stability of generic nomenclature is available in any group if the specialists concerned take the trouble to submit a list of the most important generic names and ask for them to be placed on the " Official List."

Similar means for securing stability for the trivial names of species was provided by the establishment of a new " Official List of Specific Trivial Names " with the same status as that now given to names on the " Official List of Generic Names."

It was manifestly impossible, owing to lack both of time and of the necessary technical competence, for the actual text of the revised *Règles* to be prepared at the Paris Congress. It was decided at the outset, therefore, that the Commission and the Congress should confine themselves to agreeing on the substance of the new or amended provisions to be included in the revised *Règles*, but that the actual drafting should be entrusted to expert jurists, who would be responsible for preparing both the substantive French text and an authorized literal English translation. These texts will be submitted to all members of the Commission (including alternate members) present at the Paris Congress for comments, and the final editing in the light of the comments is to be entrusted to an international committee of three consisting of Professor V. van Straelen (Belgium), Professor R. L. Usinger (U.S.A.) and Mr. Francis Hemming (Secretary to the Commission) (United Kingdom). The Congress decided

that the revised text of the *Règles* is to be published and promulgated as soon as possible and that the revised *Règles* shall come into force immediately upon being so promulgated.

In the meantime, however, a detailed record of the decisions on nomenclature of the Paris Congress will be published shortly in the *Bulletin of Zoological Nomenclature* for the information and guidance of the general body of zoologists and palaeontologists.

The *Règles* as revised at Paris represent an enormous advance over the text at present in force. The vast cobweb of case law constituted by the *Opinions* rendered by the Commission over the last 40 years has been swept away by the incorporation in the *Règles* of the decisions so rendered; ambiguities, both deliberate and inadvertent, have been deleted; numerous gaps which marred the *Règles* have been filled; many useful new provisions on minor questions have been inserted; many drafting anomalies removed; finally in cases where the existing provisions have been shown to be out of harmony with the current needs of zoologists and palaeontologists, those provisions have been changed, great care being taken at the same time to ensure that these changes shall be effected in such a way as to cause the minimum disturbance in nomenclatorial practice.

It is now nearly 50 years since the present *Règles* were adopted at Berlin and it is not surprising therefore that, although that instrument has rendered inestimable benefits to zoologists and palaeontologists, it should now be in need of a thorough overhaul and review. This it has now received. It would be too much to hope that every blemish has been removed from the *Règles* or that all the subjects which should be covered in it have in fact been so covered. We know indeed that this is not so, for the Commission and the Congress have themselves commissioned enquiries into various aspects of nomenclature which are either not dealt with in the *Règles* or are dealt with in an inadequate manner. The next Congress is due to meet in Copenhagen in five years time. At that meeting the Congress will have before it the revised *Règles* as agreed upon in Paris and with that document before it will be able both to correct any mistakes which experience may show to have been committed at Paris and also to deal with those further questions on which special enquiries are now on foot. In approaching this task the Congress will have the benefit of having before it a single text containing a coherent statement of every decision so far taken in regard to zoological and palaeontological nomenclature and will thus have the advantage of an infinitely better starting-point than that available to any previous Congress. In the meantime, the individual specialist will have escaped from the doubts and uncertainties which have for so many years impeded the application of zoological nomenclature to his day-to-day work by having placed in his hands a single volume containing the complete corpus of international law as it now exists in this field. He will be able to judge the directions in which further improvements can be made and, by putting forward constructive proposals, make his own contribution for the common good.

DISCUSSION

A. Lamont (Great Britain) said that he feared that elaborate rules made by one group of specialists might be a hindrance, rather than a help, to others, that majority decisions were not always correct in the scientific field, and that it was impossible to make a small group of specialists fully representative of the whole of zoological science. He considered that such a body as the International Commission on Zoological Nomenclature should be a consultative body and should not attempt to dictate. He deplored the fact that the high cost of printing had made necessary the publication of very brief descriptions of new species and that in some cases it was preventing or delaying the publication of important papers containing descriptions of new forms, and he hoped that the work of the Commission would lessen, not increase, the troubles of the describers of new species.

Carl O. Dunbar (U.S.A.) said that American palaeontologists were much indebted to the Commission and its Secretary for the energy shown at the recent Congress in pursuing a programme for the reform of the Code. He was confident that the results so secured would be widely welcomed.

Theodor Sorgenfrei (Denmark) said that the international rules of zoological nomenclature were tools that the palaeontologists had to use in their work, that Mr. Hemming had done much to improve these tools and make them more easily available, and that all palaeozoologists were grateful to him.

C. J. Stubblefield (Great Britain) enquired whether the Paris Congress had considered the disirability of family names continuing to exist as homonyms; he recalled the trilobite and gastropod families both called Harpidae and the trilobite and echinoid families called Scutellidae. He also enquired concerning the gender to be used for varietal names. He looked forward to the early issue of the revised code of rules and opinions promised by the speaker.

L. R. Cox (Great Britain) pointed out how important it was that palaeozoologists generally should become quickly acquainted with the important changes in the rules of zoological nomenclature that had recently been made. He considered it to be especially important that workers should be promptly informed if any modification had been made in the additions to Article 25 of the rules, whereby no generic name published after 1930 could have any status of availability unless published with a summary of its distinctive diagnostic characters or with a bibliographic reference to such a summary, and if any new general ruling had been made as to what species should be accepted as genotype when there was clear evidence (e.g. from the generic diagnosis) that the species cited as such by the author of a new genus had been misinterpreted by him.

H. J. Harrington (Argentine) protested against the publication of new genera and species in obscure journals and asked that authors be advised against following this practice.

M. P. White (U.S.A.) urged that all palaeontologists endeavour to do their descriptive work so carefully that it would not become necessary for the International Commission on Zoological Nomenclature to review it later.

Miss J. Hampson (Great Britain) noted that S. S. Berry, in the *Bulletins of American Paleontology*, volume 31, No. 127, 1947, page 6, had suggested the desirability of using the term "generitype" rather than "genotype," in referring to the type species of a genus because "genotype" was being commonly used by biologists in a different sense, and she asked if the Commission had given any guidance as to which term should be preferred.

R. V. Melville (Great Britain) said that there were in existance a great number of specific names, especially in works of early date, which, though available under the International Rules of Zoological Nomenclature had no taxonomic viability, and that in these cases, either through the loss of the material originally described, or through inadequate illustrations or description, it was impossible to attach a meaning to the names in question. He suggested that the creation of a category of nominal species might be helpful, to include a list of names which, though legally available, could not be attached to any taxonomic unit, for in this way the names would be "frozen" and any subsequent use of the same combination of words would be a homonymic usage, while freedom would be left to the systematist to deal with the taxonomic units according to his own ideas.

F. Hemming replied as follows:—

The discussion which has taken place is particularly gratifying to the Commission, because of the evidence that it has afforded of the approval felt by this representative gathering of palaeontologists in regard both to the general policy of the Commission and also to the action which it took during the recent Congress in Paris. As will be seen, most of the points raised during the discussion are now covered by the *Règles* in one form or another. The words which have fallen from Mr. Sorgenfrei and Dr. Carl O. Dunbar are especially encouraging to the Commission who regard it as their main duty to collect and mirror the wishes of the general body of workers and to assist them in their work.

I do not propose to comment in detail on the observations made by Dr. Lamont, for these were largely concerned with matters other than zoological nomenclature. In so far as Dr. Lamont's speech was concerned with nomenclature, I will only say that I recognize that there are, and probably always will be, some workers with so individualistic an outlook that no international code of nomenclature is likely to meet with their approval. These workers, however, represent to-day only a small minority. Such workers have nothing to fear from the great body of zoologists and palaeontologists who do desire to see international co-operation in matters of nomenclature. Those who desire and seek such co-operation will not interfere with the minority who do not. They do ask, however, that their work should not be unduly impeded by those who by temperament are opposed to such co-operation.

The question of family names referred to by Dr. Stubblefield is a matter of great importance particularly to those workers who are concerned with the problems of major classification, or with the teaching of zoology or palaeontology. Unfortunately it has been difficult to arouse any general interest in this matter, the nomenclature of categories above the genus level being still regarded by many workers as a proper field for individual judgment. The elaborations of these higher categories and the relative status to be accorded to each is beyond doubt a matter for specialists. Equally, however, it cannot reasonably be contended that any advantage is gained from the state of anarchy into which the nomenclature of these higher groups has now fallen. Even in the case of the family, the only member of this group of categories for which any provision is made in the *Règles*, that provision is incomplete, incoherent and thoroughly unsatisfactory. The object of the Commission is to devise a system which will serve to regulate the nomenclature of the higher categories, and by some application of the principle of homonymy, put an end to the indefensible situation under which the same name can be used as an ordinal name in two totally different classes, as in the case of the name Decapoda now used to denote both an Order of the Class Crustacea and an Order of the Class Cephalopoda. To deal with these two problems the International Congress of Zoology have invited the Secretary to the International Commission on Zoological Nomenclature to make a detailed study, and to make proposals to the next Congress (1) on the problem of securing stability in the names of Orders and higher categories, and (2) on the changes in, and additions to, the *Règles* necessary to put the nomenclature of families on a rational and consistent basis.

As regards the question of the gender of adjectival trivial names to which Dr. Stubblefield has referred, the position is that the trivial names of sub-species are subject to the same rules as those of species, and it follows therefore that whatever may be the correct gender of a given specific trivial name, the same gender is the correct gender for trivial names of sub-species and infra-sub-specific forms of that species, where those names are adjectival in character. This will be made clear in the revised text of the *Règles*.

Dr. L. R. Cox has stressed the importance of securing that the decisions taken by the Congress in Paris should be made generally known as quickly as possible. The Commission share this view, attaching the highest importance to the early publication of all the decisions taken in Paris. To this end, as already explained, the full minutes of the Paris meetings of the Commission, together with the documents submitted to them which had provided the basis of many of those decisions, will be published as soon as possible in the Commission's *Bulletin of Zoological Nomenclature*. Dr. Cox was perfectly right when he stressed the special importance of any changes made in the provisions of Article 25, for that is the one article which determines whether any given name is nomenclatorially available. Various changes have been made in that Article with the object of eliminating " ritualistic " provisions which serve no useful purpose and merely cause irritation by invalidating names on purely technical grounds. The case of the name *Howellella* proposed by Kozlowski in 1946 in nonour of Professor Benjamin Franklin Howell is probably familiar to many of you. That name was published as a substitute name for another name which is invalid under the Law of Homonymy, but under proviso (c) to Article 25 is itself invalid because, although Kozlowski made it quite clear what he was doing, he did not cite a full bibliographical reference for the earlier name as required by that proviso. One other very important reform has been introduced in Article 25 (and Article 26): the deliberately ambiguous expression " binary nomenclature ", which for half a century has constituted a serious stumbling-block in nomenclature, has been deleted by a unanimous vote of the Commission and the Congress, and the expression " binominal nomenclature " inserted in its place.

Another very important question was raised by Dr. Cox when he alluded to the problem presented by a genus, the type species of which, under the *Règles*, is, through a misidentification on the part of the original author, some species other than that which he had intended—in some cases a species which did not agree with the characters given for the genus by its original author. This question received most careful consideration from the Commission in Paris, for it was evident that stability in nomenclature might be threatened if the type species of genera were to be changed on the ground that those species had been misidentified by the original authors of the genera concerned. The Commission considered it of the upmost importance that in Article 30, as in other parts of the *Règles*, a clear distinction should be made between objective nomenclatorial facts and subjective taxonomic views. In their opinion, the former alone are relevant to a code of nomenclature. They accordingly recommended—and the Congress in Paris agreed—that, once one of the originally included nominal species has been duly selected as the type species of a genus, that type species should not be liable to be changed in the light of subjective taxonomic considerations. If in any given case this is found to operate in such a way as to cause confusion rather than uniformity, the Commission will be ready to consider an application for the suspension of the *Règles*.

Dr. H. J. Harrington has expressed the view that names ought not to be published for new taxonomic units in obscure, and especially in, non-technical journals. The Commission are in full agreement with this view and, on their proposal, the Congress has agreed to insert in Article 25 a " *Recommandation* " to authors to avoid the practice criticized by Dr. Harrington.

Mr. M. P. White has argued that workers should so write their papers as to render subsequent reference to the International Commission unnecessary. That a day may come when such references are no longer needed is the earnest hope of the Commission itself. They believe that the best way to promote this end is by bringing the *Règles* into harmony with current needs, by removing ambiguities in the text and by filling up gaps. It is for this reason that they have bent all their energies to this task.

Miss J. Hampson has touched upon a question which received careful consideration from the Commission in Paris. The expression " genotype " is so widely used by geneticists in a sense totally different from that in which it is still employed by some zoologists and palaeontologists (namely as a term denoting the type species of a genus) that the Congress, on the proposal of the Commission, agreed to insert a " Recommendation " urging workers to discontinue the use of this expression, and in its place to use the expression " type species " ("espèce type "). Before reaching this conclusion, the Commission examined the various other expressions which had been suggested, including that referred to by Miss Hampson, but it was found that, apart from the fact that many of these expressions have won little or no support, they are, without exception, open to the objection that, while their meaning in English might be clear, they could not be used in the Romance languages without a serious risk of confusion or ambiguity.

Mr. R. V. Melville has raised a point which is much more one of taxonomy than of nomenclature. The existence of large numbers of *nomina dubia* is, no doubt, a threat to the stability of nomenclature and constitutes a problem which I would like to see the Commission tackle. Something might be achieved through the recognition, subject to certain conditions, of neotypes. Mr. Melville has put forward an interesting proposal for dealing with *nomina dubia* and this will receive the careful consideration of the Commission.

In conclusion, I should like to thank the International Paleontological Union for the opportunity given to me for addressing the present meeting on recent advances in zoological and palaeontological nomenclature.

QUADRINOMINAL NOMENCLATURE

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ABSTRACT

Studies of variability and bastardization on Tertiary molluscs (*Cerithium, Melanopsis, Viviparus, Congeria, Limnocardium*) prove that the meaning and the limits of most genera and species may be altered at will. These limits are non-existent but are only conventional, so they cannot have natural distinguishing characters, only artificial ones. As there always will be specialists who wish to see their names after " nova genera," etc., the system and the nomenclature are threatened by chaos. The only way I can think of remedying this is by a quadrinominal nomenclature. This, to some degree, has been already used, but not compulsorily. The first and third names (supergenus and superspecies) should not be altered without consent of the Palaeontological Congresses; The second and fourth names (genera or subgenera, and species, subspecies or variety) might be at the disposal of the enthusiastic reformers. It is true that by this the palaeontological names would become longer, and require more space in print, but not so much as by disputing always the priority and meaning of the names. Just as a small town can be served with telephone numbers of three figures, and a big capital must have six figures, so the duplication of the palaeontological names is justified by the horrible increase of the number of known forms.

THE chief purpose of biological nomenclature is to be intelligible. One regrets, however, that year after year the index of Tertiary molluscs becomes less intelligible. Nearly all species have two or more synonyms. Again it is often hard to say which form is a variety, and which is a species. The majority of species may be placed in as many different genera as one likes. One may with equal justification call a form *Chione*, *Clausinella*, or *Circomphalus*; *Lucina reticulata* may also be called *Codokia decussata*. The greatest difficulties of the binominal nomenclature of to-day are that if the limits of genera are too elastic, an immense number of species will belong to each of them, and if generic concepts are kept rigid, then most of the species remain outside the limits of any one genus, usually in the void between two ideal genera; but it is possible that one may consider a species as belonging to both genera. In the latter case, when genera are set too rigidly they cause another difficulty, not in principle, but in practice; that is, that there will be so many names of genera that nobody can learn them.

Studying the fossils of hundreds of localities in the younger Tertiary Beds of Hungary I have always observed that the variability of the molluscs is greater and more common than one thinks after reading their descriptions. Two species, or one species and its single variety very obviously may differ if there are no more than two specimens in the collection. Each specimen found later makes the supposed differences weaker and weaker and proves the existence of disagreeable middle-forms between the two compact extremes. One must accept the fact that the Upper Pannonian form *Limnocardium apertum* Mü. and *L. secans* F. cannot be separated (Strausz 1942, p. 64), *Limnocardium vutskitsi* B. is identical with *L. dainellii* B. (op. cit., p. 72), *Congeria batuti* B. with *C. turgida* B. (op. cit., p. 75); three forms: *Melanopsis caryota* B., *M. petrovici* B. and *M. cylindrica* Stol. are bound together with continuous transitions (*op. cit.*, p. 85–87). In the Upper Mediterranean (Tortonian) *Venus scalaris* Brn. and *V. basteroti* Desh. (Strausz 1943, p. 142), *Terebra acuminata* Bors. and *T. transylvanica* H. et Au. (Strausz 1943, p. 144), *Pleurotoma ramosa* and *P. elisae* H. et Au. (Strausz 1943, pp. 144–145), *Chemnitzia perpusilla* Grat. and *Ch. cylindrata* Boettg. (Strausz 1945–6, p. 31), *Turritella bicarinata* Eichw. and *T. conospira* Boettg. (Strausz 1945–6, p. 31) may be quoted as such pairs of " species " where the two extremes are only slightly aberrant types of a continuous line of variation, and so do not deserve different names. *Venus plicata* Guel. does not differ in constant and well-defined characteristics from its two varieties (Strausz 1943, p. 142) described by Kautsky. In the Leytha-limestones of

Budapest immense variability of Pectens (related to *Chlamys malvinae* Dub.) was observed (Strausz 1927, pp. 342–343) which would be enough to create dozens of " species " from them, but these are all connected with transitions.

Variability and bastardization are very common among the Melanopsides. I have established (Strausz 1943) the existence of middle-forms between *Melanopsis oxyacantha* B. and *M. kurdica* B., between *M. bouéi* Fér. and *M. pygmaea* Fér., and between *M. bouéi* Fér. and *M. confusa* Strausz. Many other transitions between different species or between the varieties of the same species have been described by other authors.

The variability of forms of *Viviparus* is also long known. In my paper concerning the Upper Pannonian *Viviparus*-forms of Transdanubia (Strausz 1942a) I have established that (*a*) two groups of forms (*V. sadleri* s.l and *V. kurdensis* s.l) are geographically separated, (*b*) both groups of forms include varieties which have all kinds of transitions within each group, but without any transitions from one group to the other, (*c*) in every locality containing more than one of these forms of *Viviparus*, the transitions are present, the middle-forms being more common than the extreme varieties. I have not only determined the character of these varieties by general appearance, but made measurements of these (Strausz 1942a, pp. 54, 55) and by numerical data have proved the preponderance of the middle-forms in all localities examined. Similar measurements and numerical analysis were performed with the variability of *Cerithium pictum* Defrance (Strausz 1944 and 1947). Here the type of the ornamentation (rows of nodules) and the number of the nodules in the upper (strongest) spiral row were listed. Such statistics have shown that the Upper Mediterranean form (*Cerithium pictum* s. str.) and the supposed Sarmatian species (*C. mitrale* Eichw.) may not be separated, the varieties of every locality here also form continuous lines, the extreme variations being rare, and the middle-ones more frequent.

Not only transitions of species, but transitions or middle-forms of different genera are also to be found. So the independence or separateness of the genera *Goniochilus* and *Prososthemia* (Strausz 1942, p. 83), or *Bullinella* and *Retusa* (Strausz 1945–6, pp. 27 and 31), and of *Circomphalus* and *Clausinella* (Strausz 1943, p. 142 and 1945–6, p. 25) are to be denied. A specimen of *Dentalium* was found (Strausz 1945–6, p. 31) in the Upper Mediterranean (Tortonian) of Welzelsdorf (Styria) which demonstrates well the immense variability of this group of molluscs. The posterior (thinner) half corresponds absolutely with *D. sexangulum*; in the middle of the length two more ribs appear; the anterior part is octangular, and here the sculpture is identical with that of *D.* (*Antale*) *mutabile*. So one single specimen belongs to two different subgenera; *Dentalium* and *Antale*.

All this proves that the limits of palaeontological systematic units are indistinct, and therefore nearly all names are disputable. One may change most names if one likes, and create new ones. As there always will be specialists who wish to see their names after " nova genera " etc., the system and the nomenclature are threatened by chaos. The only way I can see of remedying this is by a quadrinominal nomenclature. This, to some degree has been already used, but not compulsorily. The first and third names (supergenus and superspecies) should not be altered without consent of the Palaeontological Congresses; these names should not be of " real scientific " value, only of " practical " value, aiding in the better understanding of the nomenclature. The second and fourth names (genera or subgenera, and species, subspecies or variety) might be at the disposal of the enthusiastic reformers. These second and fourth names could be altered and made as rigid as one desires. The latter would really be " scientific names," although not always intelligible and not important to remember. It is true that by this the palaeontological names would become longer, and require more space in print, but not so much as by disputing always the priority and meaning of the names. Just as a small town can be served with telephone numbers of three figures, and a big capital must have six figures or more, so the duplication of the palaeontological names is justified by the horrible increase of the number of known forms.

I hope it will not be very difficult to select names for supergenera. Old Monographs of general reputation (e.g. M. Hörnes' *Neogene Molluscs of the Vienna Basin*) may be taken as standards for these

names. There would be more trouble with the names of superspecies. In many cases genus and superspecies names would be identical, in other cases—for lack of older data—new names of superspecies must be created for newly found fossils. Such quadrinominal designations were e.g.:

Pleurotoma Genota ramos elisae
Chemnitzia Sandbergeria perpusilla cylindrata
Cardium Ringicardium hians danubiana
Venus Clausinella basteroti scalaris

although the last-mentioned shell could equally well be called "*Venus Chione scalaris scalaris.*" I do not claim that all difficulties can be eliminated by this quadrinominal nomenclature; but I am convinced that without it there are no means of avoiding chaos; using it we shall be able to create an intelligible, though not a beautiful nomenclature.

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DISCUSSION

J. F. HAYWARD (Great Britain) said that all palaeontologists, and especially those who had subjected fossils to statistical examinations, realized that the problem described by Dr. Strausz was a very real one, but that whether the solution proposed by Dr. Strausz was the best one was more debatable. He noted that one disadvantage of the proposed system, its unwieldiness, had already been recognized, but he thought that this might be overcome by making the quadrinominal nomenclature permissive, rather than compulsory, so that authors who were not concerned with detailed subdividing could quote the first and third names only (so that, for example, "*Cardium hians*" would mean *C. hians.* s.l.) and could leave it to others to burden their works with the more narrowly defined names.

L. R. COX (Great Britain) noting that one of the suggestions contained in Dr. Strausz's paper was, virtually, that the erection of new genera and species (in the older sense), which it was now proposed to term "supergenera" and "superspecies," should be subject to the control of Palaeontological Congresses, said that, in his opinion, this would prove altogether impracticable. He considered that the "splitting" of the older genera by some systematists had exceeded reasonable limits (he cited *Trigonia* as a case in point) and that the use of subgeneric names for well-defined groups within such genera would be preferable to the multiplication of genera. He hoped that systematists, however specialized their studies, would be guided by some sense of proportion when erecting new taxonomic groups and assigning them to their respective categories.